

137-1958-2-2338

A New Method for the Study of the Equilibrium (cont.)

method was used to determine at various temperatures the distribution of P between a low-carbon Fe and a slag consisting of 33.6% CaO, 2.1% Na<sub>2</sub>O, 28.4% Al<sub>2</sub>O<sub>3</sub>, 4.6% SiO<sub>2</sub>, 1.8% MgO, 25.0% FeO, 6.3% Fe<sub>2</sub>O<sub>3</sub>, and 2.1% P<sub>2</sub>O<sub>5</sub>. The results obtained are quite accurately stated by the equation:

$$\log K_P = \log \frac{(\%P)}{[\%P]} = \frac{16,000}{T} - 6.94$$

K<sub>P</sub> was determined from the ratio of the counting rate of an original slag sample to the counting rate of a metal sample taken after equilibrium had been attained. This method was used also to determine the distribution of S between Fe and slags consisting of: 1) 50% CaO and 50% Al<sub>2</sub>O<sub>3</sub>; 2) 45% CaO, 45% Al<sub>2</sub>O<sub>3</sub>, and 10% MnO. In both cases the heat flow from the Fe to the slag was nearly 40 kcal/gram atom.

I. T.

1. Metal slag systems--Application
2. Equilibrium--Test methods
3. Equilibrium--Test results

Card 2/2

137-1958-2-2345

SHVARTSMAN, L.A.

Translation from: Referativnyy zhurnal, Metallurgiya, 1958, Nr 2, p 20 (USSR)

AUTHORS: Shvartsman, L.A., Tomilin, I.A., Travin, O.V., Popov, I.A.

TITLE: The Effect of the Oxides of ~~Al~~ <sup>Al</sup> Earth Metals on the Distribution of Sulfur Between Iron and Ferruginous Slag (Vliyaniye okislov shchelochnozemel'nykh metallov na raspredeleniye sery mezhdz zhelezom i zhelezistym shlakom)

PERIODICAL: V sb.: Fiz.-khim. osnovy proiz-va stali. Moscow, AN SSSR, 1957, pp 304-318. Diskus., pp 332-334

ABSTRACT: The radioactive isotope  $S^{35}$  was used to study the dependence on the temperature of the distribution of S between Fe and a slag consisting of Fe oxides. The results are described by the equation

$$\log K_s = \left( \frac{3000}{T} \right) - 1.05$$

wherein  $K_s$  is the coefficient of distribution of S, computed as the ratio of the counting rate from the slag to the counting rate from the metal, the counting rates being computed by the thick-layer method. The MgO content of the ferruginous slag, so long as it did not exceed 7.76%, exhibited no influence either on the  $K_s$  value

Card 1/2

137-1958-2-2345

The Effect of the Oxides of Alkaline-Earth Metals (cont )

or on its dependence on temperature. With the maximum precision attainable in the experiment it was found that the CaO content, up to 12%, likewise did not alter the  $K_s$  value. For ferruginous slag containing more than 12% CaO it was learned that

$$\log K_s = \left( \frac{3700}{T} \right) - 1.26 .$$

This equation is correct for a CaO content up to 33%. The smallness of the effect exerted by the CaO on the K value is accounted for by the increase that occurred in the  $Fe_2O_3$  concentration when CaO was introduced into the slag. For a slag containing 11.5 - 16.2% BaO, the equation obtained was  $\log K_s = (3200/T) - 0.99$ .

From the dependence on temperature of  $K_s$  a computation was made of the heat effect of the desulfurization of the Fe by a slag consisting only of Fe oxides + 14 kcal/gram.atom, with addition of more than 12% CaO + 17 kcal/gram.atom and 11-16% BaO + 14 kcal/gram.atom. The smallness of the heat effect and the smallness of the difference between them when one oxide was substituted for another are accounted for by the absence in ferruginous slags of any specific chemical reaction of oxides of Ca, Ba, and Mg with S.

I.T.

Card 2/2

1. Sulfur--Distribution
2. Iron--Applications
3. Slag--Applications
4. Alkaline earths--Oxidation--Effects

SHVARTSMAN, L. A.

137-1958-1-223

Translation from: Referativnyy zhurnal, Metallurgiya, 1958, Nr 1, p 34 (USSR)

AUTHORS: Travin, O.V., Shvartsman, L.A.

TITLE: Kinetics of Sulfur Transport from Pig Iron Into a  $\text{CaO-Al}_2\text{O}_3$  Type Slag (Kinetika perenosa sery iz chuguna v shlak sistemy  $\text{CaO-Al}_2\text{O}_3$ )

PERIODICAL: V sb.: Fiz.-khim. osnovy proiz-va stali. Moscow, AN SSSR, 1957, pp 319-331. Diskus. pp 332-334

ABSTRACT: In the light of the results obtained and the concepts of electro-chemistry, the Authors suggest the following mechanism for the transfer of S from iron to slag:  $[\text{S}] + 2e \rightleftharpoons (\text{S}^{--})$   $[\text{Fe}] \rightleftharpoons (\text{Fe}^{++}) + 2e$  (1) and  $[\text{Fe}] + [\text{S}] \rightleftharpoons (\text{Fe}^{++}) + (\text{S}^{--})$  (2). If the Fe contains deoxidizing elements, reaction (1) may be competing with other processes also making for adherence to the conditions of electrical neutrality, for example.  $[\text{C}] + (\text{O}^{--}) \rightarrow \text{CO}_{\text{gas}} + 2e$ ;  $[\text{Si}] + 2(\text{O}^{--}) \rightleftharpoons (\text{SiO}_2) + 2e$ ;  $(\text{O}^{--}) \rightleftharpoons [\text{O}] + 2e$ . On the assumption that the limiting stage of the entire process of desulfuration is the molecular transport of the S ion into the slag via the diffusion layer on the boundary with the metal, the A's derive the following kinetic equation:

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$$d[\%S] / dt = DA \cdot k [\%S]_p / \delta$$

137-1958-1-223

Kinetics of Sulfur Transport From Pig Iron (cont.)

where  $D$  is the coefficient of diffusion of  $S$ ,  $k$  is the mass transport coefficient, and  $\delta$  is the effective thickness of the diffusion layer. It was found that the rate of desulfuration is proportional to the concentration of  $S$  in the iron, with the exponent subject to temperature variations. When the temperature is low, the exponent is close to unity and the reaction is monomolecular. At higher temperatures, the order of reaction is fractional and tends toward 2. See RzhMet, 1956, Nr 2, 1000.

I.P.

1. Iron--Purification
2. Iron--Processing--Desulfurization
3. Electrochemistry--Applications

Card 2/2

137-58-4-6566

Translation from: Referativnyy zhurnal, Metallurgiya, 1958, Nr 4, p 36 (USSR)

AUTHORS: Malkin, V.I., Shvartsman, L.A.

TITLE: Measuring the Ion Transference (Hittorf) Number of the  $\text{Ca}^{2+}$  in Fused  $\text{CaO-P}_2\text{O}_5$  (Izmereniye chisla perenosa iona  $\text{Ca}^{2+}$  v rasplave  $\text{CaO-P}_2\text{O}_5$ )

PERIODICAL: V sb. Fiz. -khim. osnovy proiz-va stali. Moscow, AN SSSR, 1957, pp 433-437. Diskus. pp 505-512

ABSTRACT: The following method was used to measure the ion transference numbers in oxide melts. A small corundum-coated crucible, having a 1-1.5 mm aperture at its bottom, was placed in a large-diameter crucible of the same materials. The slag (27%  $\text{CaO}$ , 73%  $\text{P}_2\text{O}_5$ ) was charged into the crucibles and weighed. The slag contained  $\text{Ca}^{45}$ . Graphite electrodes were lowered into the melt on attainment of 1000°C temperature. After current had been passed through it, the electrodes were removed and the crucible weighed with its diaphragm and contents. The loss of weight in the course of the experiment was determined in this way. Then the crucible was broken, and the weights of the catholyte and anolyte were

Card 1/2

137-58-4-6566

# Measuring the Ion Transference (cont.)

determined separately. The Hittorf number  $x_1$  of the Ca ion through the anodic space was calculated from the equation:

$$x_1 = \frac{p \cdot q_f}{K \cdot E_1} \left( 1 - \frac{I_f}{I_i} + \frac{q_a}{q_f} \right),$$

where  $q_f$  was the weight of the anolyte after the experiment,  $q_a$  was the weight loss of the anolyte during the experiment,  $I_i$  and  $I_f$  were the radioactivities of the anolyte before and after the experiment,  $p$  was the weight percentage of the  $\text{Ca}^{2+}$  ion before the experiment,  $K$  was the quantity of electricity in farads, and  $E_1$  was the numerical value of a gram-equivalent of the  $\text{Ca}^{2+}$  ion. Here  $q_a$  was computed from the equation  $q_a = K(E_1 + E_2)x_1$ , where  $E_2$  was the numerical value of a gram-equivalent of the  $\text{O}^{2-}$  ion. Four experiments yielded the following values of  $x_1$ : 1.06, 1.04, 1.06, 1.02. These data show that the conductivity of the melt is by a single cation.

I. K.

- 1 Metallurgy    2 Melts--Applications    3 Ion exchange--Measurement

Card 2/2

SHVARTSMAN, ~~ADOS~~ L. A.

✓ Measurement of transference numbers in molten oxide mixtures. V. I. Melkin, S. P. Khokhlov, and L. A. Shvartsman (Central Iron and Steel Research Inst., Moscow). *Intern. J. Appl. Radiation and Isotopes* 2, 19-25 (1967) (in English). -- The transference nos. of  $\text{Na}^+$  and  $\text{Ca}^{++}$  were measured in  $\text{CaO-P}_2\text{O}_5$ ,  $\text{Na}_2\text{O-2SiO}_2$ ,  $\text{Na}_2\text{O-CaO-4SiO}_2$ , and  $\text{CaO-Al}_2\text{O}_3\text{-SiO}_2$  with  $\text{Na}^+$  and  $\text{Ca}^{++}$  as tracers. The advantage is that small changes of compn., which obviate side effects and side reactions, can be measured in the anolyte; the amt. of electricity passed through the soln. does not exceed 0.03 Faraday. The transference no. of the cation in the binary systems is nearly unity, whereas  $\text{Na}^+$  is much more mobile than is  $\text{Ca}^{++}$  in the ternary oxide; practically the total current is carried by the cations. In the system  $\text{CaO-Al}_2\text{O}_3\text{-SiO}_2$ ,  $\text{Al}^{+++}$  competes with  $\text{Ca}^{++}$ . The method permits study of the relation between charges

and dimensions of cations and their mobility in oxide melts.  
Walter G. Rothschild



OSIPOV, A.I.; SHVARTSMAN, L.A.; ALEKSEYEV, V.I.; SUROV, V.F.;  
SAZONOV, M.L.; BUL'SKIY, M.T.; TELESOV, S.A.; SKREBTSOV,  
A.M.; OFENGENDEN, A.M.; GOL'DSHTEYN, L.G.; SVIRIDENKO, F.F.

Radioisotope studies of scrap fusion kinetics and slag formation  
in the scrap-ore process. Atom.energ. 3 no.10:352-355 0 '57.  
(MIRA 10:10)  
(Steel--Metallurgy) (Radioisotopes--Industrial applications)

SHVARTSMAN, I. A. (Moscow).  
 24-4-26/34  
 AUTHORS: Tomilin, I.A., Khokhlov, S.F. and Shvartsman, I.A.  
 TITLE: Influence of admixtures of calcium and sodium oxides on the distribution of the sulphur between the iron and the acidic slag. (Vliyanie dobavok okislov kal'tsiya i natriya na raspredeleniye sery mezhdz zhelezom i kislym shlakom).  
 PERIODICAL: "Izv. Ak. Nauk, Otd. Tekh. Nauk" (Bulletin of the Ac. Sc., Technical Sciences Section), 1957, No.4, pp.152-156 (USSR).  
 ABSTRACT: In a previous paper (Izv. Ak. Nauk, Otd. Tekh. Nauk, 1953, No.12) the authors studied the distribution of sulphur between the iron and the acidic slag consisting of a melt of iron oxides which were saturated with silica. In this paper the results are described of studies of the influence on this equilibrium of additions of calcium and sodium oxides to the acidic slag. The used technique was described earlier (1) and (2). The slag was first smelted and the mixture for smelting was prepared from chemically pure iron oxide and quartz powder to which a certain quantity of calcium and sodium carbonate were added. The investigations were carried out by means of the radio-active isotope  $S^{35}$ . The curves of self-absorption were also measured for a slag consisting of iron oxides and a slag of a complex composition containing about 20%  $Na_2O$ , about 30% iron oxides and about 50%  $SiO_2$ ; the results of these measurements are given in Fig.1. The results of the tests

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Influence of admixtures of calcium and sodium oxides on the distribution of the sulphur between the iron and the acidic slag. (Cont.).  
24-4-26/34

in which the equilibrium was studied are given in the Tables 2 and 3 and in the graphs 2 and 3. The heat of transition of the sulphur from the iron into the slag of the system  $\text{FeO-SiO}_2$  which is saturated with silica, decreases if calcium oxide is added to the slag. For a calcium concentration of about 20% the reaction heat amounts to about 13 000 cal/g-atom, which almost corresponds to the heat of transfer of the sulphur from the iron into the ferrous slag. In addition, an increase in the  $\text{CaO}$  concentration in the slag brings about some increase in the entropy of the  $\text{FeS}$ . The overall result of these processes is a decrease of the sulphur distribution coefficients compared to the acidic slag not containing  $\text{CaO}$ . Introduction of  $\text{Na}_2\text{O}$  into the investigated slag causes the same phenomena to a still more intensive degree. These phenomena are attributed to the specific interaction of the ions in the acidic melt. There are 3 figures, 3 tables, 8 references, 7 of which are Russian.

Card 2/2

ASSOCIATION: Institute of Metallography and Metal Physics, TsNIChM.

SUBMITTED: July 17, 1956.

AVAILABLE:

SOV/137-58-10-20933

Translation from: Referativnyy zhurnal, Metallurgiya, 1958, Nr 10, p 80 (USSR)

AUTHOR: Shvartsman, L.A.

TITLE: Employment of Induction Heating for Normalization of Butt-welded Seams of Drill and Exploratory Casings (Primeneniye induktsionnogo nagreva dlya normalizatsii stykosvarnykh shvov buril'nykh i geologorazvedochnykh trub)

PERIODICAL: Novosti nef. tekhn. Neftepromysl. delo. 1957, Nr 12, pp 26-27

ABSTRACT: A description is presented of a more productive method of normalizing welded seams of drill casings outside the clamps of welders by induction heating with standard-frequency current. Employment of high-frequency current (2500-8000 cps) is also effective as a method of normalizing welded seams of large-diameter drill casings.

1. Pipes--Welding
2. Seam welds--Heat treatment
3. Induction heating--Applications

V.O.

Card 1/1

SHVARTSMAN, L. A.

DYKHNE, A.M., inzhener; OSIPOV, A.I.; SHVARTSMAN, L.A.; IUDIN, V.Ye.

Formula for calculating the time for the equalization of the composition of the bath in open-hearth furnaces. Zav. lab. 23 no.4:506-507 '57. (MLRA 10:6)

1. Kuznetskiy metallurgicheskiy kombinat (for Dykhne).  
(Open-hearth process)

SHVARTSMAN, L. A.

4  
4E2C

✓ 13473\* (Russian.) Acid-Base Properties of Metallurgical  
Slags. Kislотно-основные свойства металлургических шла-  
ков. L. A. Shvartsman and L. A. Tomilin. *Uspekhi Khimii*,  
v. 26, May 1957, p. 554-567.  
Study of acid-base properties of oxides and their mixtures.

RG  
RM up

SHVARTSMAN, L.A.; TOMILIN, I.A.

"Use of radioactive isotopes in metallurgy." Reviewed by  
L.A. Shvartsman, I.A. Tomilin. Zhur.fiz.khim. 31 no.3:740-742  
Mr '57. (MLRA 10:7)  
(Radioisotopes--Industrial applications) (Metallurgy)

AUTHOR: Malkin, V.I., Khokhlov, S.F., Shvartsman, L.A. 76-11-16/35

TITLE: Determination of the Cation Transport Numbers in the Melt  
 $\text{Na}_2\text{O} \cdot \text{K}_2\text{O} \cdot 4\text{SiO}_2$  (Izmereniye chisel perenosy kationov v rasplave  
 $\text{Na}_2\text{O} \cdot \text{K}_2\text{O} \cdot 4\text{SiO}_2$ )

PERIODICAL: Zhurnal Fizicheskoy Khimii, 1957, Vol. 31, Nr 11, pp. 2485-2487  
 (USSR)

ABSTRACT: The relative mobility of the cations  $\text{Na}^+$  and  $\text{K}^+$  with a charge, the radii of which differed noticeably from each other, was investigated in a silicate melt, the composition of which corresponds to the formula  $\text{Na}_2\text{O} \cdot \text{K}_2\text{O} \cdot 4\text{SiO}_2$ . For the determination of the transmission numbers for  $\text{Na}^+$  and  $\text{K}^+$  the method [Ref.2] described already previously was applied by making use of the radio isotopes  $\text{Na}^{24}$  and  $\text{K}^{42}$ . The results of the experiments were somewhat surprising. They showed that the mobilities of the  $\text{Na}^+$ - and  $\text{K}^+$ -ions are nearly equal in the melt investigated here. There are 1 figure and 6 references, 3 of which are Slavic

Card 1/2



76-11-16/35

Determination of the Cation Transport Numbers in the Melt  $\text{Na}_2\text{O} \cdot \text{K}_2\text{O} \cdot 4\text{SiO}_2$

ASSOCIATION: Institute for Metallurgy and Metal Physics. Central Scientific Research Institute of Ferrous Metallurgy, Moscow (Institut metallovedeniya i fiziki metallov. Tsentral'nyy nauchno-issledovatel'skiy institut chernoy metallurgii, Moskva)

SUBMITTED: July 14, 1956

AVAILABLE: Library of Congress

Card 2/2

511 V H K T S M H Y L 11  
AUTHOR  
TITLE

PERIODICAL

ABSTRACT

KOZHEVNIKOV I.Yu., SHVARTSMAN L.A.

On the Thermodynamics of the Dephosphoration of Iron.

(O termodinamike reaktsii defosforatsii zheleza -Russian)

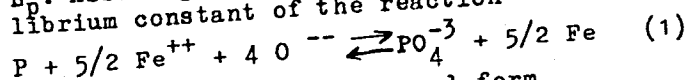
Doklady Akademii Nauk SSSR, 1957, Vol 113, Nr 2, pp 376-379 (U.S.S.R.)

Reviewed 7/1957

Received 6/1957

20-2-38/67

Many papers dealt with the phosphorus distribution in the system: metal-slag. On account of difficulties in the experiments, however, the exact values of thermodynamic functions of dephosphorization reactions of iron by slag of different composition are lacking. In the present paper a new investigation method of the distribution equilibrium of phosphorus is applied. Its fundamental idea is an effective saturation of the metal with radioactive phosphorus introduced into the slag at the very beginning at a constant temperature. This method makes it possible to compute the values both of the thermal effect and of the reaction entropy of the dephosphorization for slag of a certain composition from the temperature dependence of the exponent of the phosphorus distribution  $L_p$ . Assuming any molecular composition of molten slag the equilibrium constant of the reaction



can be described in a general form

$K_a = L_p \varphi(\sum C_i) f(\sum \gamma_i) \quad (2)$  where  $\varphi(\sum C_i)$  denotes the relation of the equilibrium concentrations of the reaction participants with

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On the Thermodynamics of the Dephosphoration of Iron. <sup>20-2-38/67</sup>  
 the exception of phosphorus, and  $f(\sum \gamma_i)$  denotes the relation of  
 the activity coefficients of all reaction participants. The cha-  
 racter of these functions is unknown. However,  $\varphi(\sum C_i)$  does not  
 depend on temperature. After further computations the authors ob-  
 tain the value  $\Delta H$  which denotes the sum of the reaction heat  $\Delta H^0$   
 between the pure substances and the heat of the mixtures  $\sum \Delta H_{CM}$ .  
 $\Delta S^0$  is the entropy modification at the transition of the phospho-  
 rus from a 1 per cent solution in iron into a 1 per cent solution  
 in the slag. As the simplest standard system ferruginous slag was  
 selected, in which cations in form of oxides:  $Ca^{++}$ ,  $Sr^{++}$  and  $Ba^{++}$   
 were introduced, which differ considerably by the radius value.  
 The results obtained about phosphorus distribution between iron  
 and ferruginous slag are described by the equation

$lg L_p = \frac{10900}{T} - 6,41$ , from which the value  $\Delta H$  is equal to  
 50.000 kal/g-pressure gauge. In this case  $K_a = \Delta L_p \frac{\sqrt{PO_4^3}}{\sqrt{P}}$ , where  $\Delta$   
 - is the transition coefficient from weight percents to molar sha-  
 res. From the temperature dependency  $K_a$  it can be obtained:  $\Delta H^0 =$   
 $= \Delta H + \Delta H_{CM}^{PO_4^3} - \Delta H_{CM}^P$ . For slag of complicated compositions

$H_{CM}^P$  remains invariable. The results of the investigation show  
 that the entropic component of the free energy which depends  
 on the charge magnitude and the mutual position of the ions in  
 the fused mass of the slag has an important influence on the  
 equilibrium of the dephosphorization reaction. This influence

Card 2/3

On the Thermodynamics of the Dephosphoration of Iron. 20-2-38/67  
anionical. ~~XXXXXXXXXX~~  
(With 4 illustrations, 2 citations from Slav publications).

ASSOCIATION Institute for Metallography and Metallic Physics of the Central  
Scientific Research Institute for Iron-Metallurgy.  
PRESENTED BY KURDYUMOV G.V.  
SUBMITTED 25.10.1956  
AVAILABLE Library of Congress  
Card 3/3

*Shvartsman, L.A.*  
KURDYUMOV, G.V., otvetstvennyy red.; SAMARIN, A.M., red.; SHVARTSMAN, L.A.,  
red.; MALKIN, V.I., red.; GOLIKOV, V.M., red.; RABEZOVA, V.A.,  
red.; CHERNOV, A.N., red. izd-va; SIMKINA, Ye.N., tekhn. red.;  
KASHINA, P.S., tekhn. red.

[Metallurgy and physical metallurgy proceedings of the Conference  
on the Use of Radioactive and Stable Isotopes and Radiation in the  
National Economy and in Science] Metallurgiya i metallovedenie;  
trudy Vsesoyuznoi nauchno-tekhnicheskoi konferentsii po primeneniyu  
radioaktivnykh i stabil'nykh izotopov i izlucheni v narodnom  
khoziaistve i nauke. Moskva, Izd-vo Akad. nauk SSSR, 1958. 518 p.  
(MIRA 11:6)

1. Vsesoyuznaya nauchno-tekhnicheskaya konferentsiya po primeneniyu  
radioaktivnykh i stabil'nykh izotopov i izlucheni v narodnom  
khozyaystve i nauke. 1957.

(Metallurgy)

(Physical metallurgy)

SHVARTSMAN, L. A.

1A(6) PHASE I BOOK EXPLANATION SOV/1726

Abdumeliya msh 2228. Institut metallurgii  
Sovremennyye problemy metallurgii (Modern Problems in Metallurgy)  
Moscow, Izd-vo AN SSSR, 1958. 640 p. 5,000 copies printed.

Reep. Ed.: A.M. Samarin, Corresponding Member, USSR Academy of  
Sciences; Ed. of Publishing House: V.S. Rachevnikov, and  
A.M. Barmov; Tech. Ed.: T.V. Polyakova.

PURPOSE: This book is intended for scientific and technical per-  
sonnel in the field of metallurgy.

CONTENTS: This is a collection of articles on certain aspects of  
Soviet metallurgy. The book is dedicated to Academician  
Ivan Pavlovich Mardin on the occasion of his 75th birthday. The  
book is divided into seven parts. The first part consists of  
two articles presenting a brief account of the biography and  
professional activity of the Soviet metallurgist. It includes an  
article by Jean Chipman, Nicholas Grant, and John Elliott (M.I.T.,  
USA) describing their meeting with Mardin in Moscow and also his  
visit to the United States. The second part consists of three  
articles and deals with raw materials and fuels for the Soviet  
metallurgical industry. The third part represents the major  
portion of the book. It consists of 25 articles dealing with  
the various aspects of the metallurgy of pig iron and steel.  
The fourth part consists of two articles treating the metal-  
lurgy of nonferrous metals. The fifth part consists of three  
articles on the forging of metals. The sixth part consists of  
eight articles discussing certain aspects of physical metallur-  
gy. The last part deals with general problems in the field  
of metallurgy. References are given after each article. No  
permissions are mentioned.

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Card 8/12

SOV/137-58-8-16481

Translation from: Referativnyy zhurnal, Metallurgiya, 1958, Nr 6, p 35 (USSR)

AUTHORS: Osipov, A.I., Shvartsman, L.A., Iudin, Ye. V., Sazonov, M. L.

TITLE: On the Uniform Distribution of Small Quantities of a Substance in the Slag During Smelting of Steel in a 350-t Furnace (O ravnomernom raspredelenii maloy dobavki v shlake pri vyplavke stali v 350-t pechi)

PERIODICAL: V sb.: Staleplavil'n. proiz-vo. Moscow, Metallurgizdat, 1958, pp 218-224

ABSTRACT: In order to investigate the problem of the rate at which a substance distributes itself uniformly in a slag during open-hearth smelting, a radioactive isotope,  $\text{Ca}^{45}$ , encased in an ampoule, was introduced into the slag through the central opening of the furnace; slag samples were withdrawn through the other openings. The intensity of radioactivity was measured with a BFL-25 counter. The counting rate was determined by the thick-layer method, a procedure which eliminated the need for weighing operations. The accuracy of the radiometric measurements constituted 5% including statistical errors and errors caused by disturbances in geometric conditions of

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SOV/137-58-8-16481

On the Uniform Distribution of Small Quantities of a Substance (cont.)

measurement. The rate of distribution of a small quantity of an additive is smaller in slag than in metal; 30-35 minutes are required for leveling off of the tracer in the case of slag, and 8-15 minutes in the case of metal, despite the fact that the volume of slag is considerably smaller. Rates of turbulent diffusion of Ca in the slag amount to 50-100 cm<sup>2</sup>/sec and are smaller by one order than the corresponding values of radioactive Co in steel; in this connection, the author comments on an analogous difference between the kinematic viscosity of steel and that of basic open-hearth slags. The distribution of radioactive Ca in the slag is strongly affected by the aerodynamic pressure of the flame.

L.K.

1. Steel--Production
2. Slags--Properties
3. Metals--Distribution
4. Calcium isotopes (Radioactive)--Performance

Card 2/2



SHVARTSMAN, L.A., doktor khim.nauk; MALKIN, V.I., kand.tekhn.nauk;  
~~TOMLIN, I.A., kand.tekhn.nauk~~

A.N. Morozov's article "Modern slag theory and the theory of  
steel smelting processes." Izv. vys. ucheb. zav.; chern. met.  
no.7:63-65 J1 '58. (MIRA 11:10)  
(Steel--Metallurgy)

SOV/24-58-10-17/34

1  
AUTHORS: Kozhevnikov, I. Yu., Shvartsman, L. A. (Moscow)

TITLE: Thermodynamics of the Dephosphorization Reaction of Liquid Iron with Four-Component Open-Hearth Type Slags (Termo-dinamika reaktsii defosforatsii zhidkogo zheleza chetyrekh-komponentnymi shlakami martenovskogo tipa)

PERIODICAL: Izvestiya Akademii nauk SSSR, Otdeleniye tekhnicheskikh nauk, 1958, Nr 10, pp 104-109 (USSR)

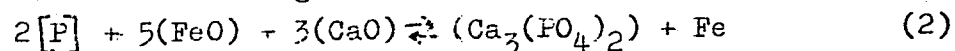
ABSTRACT: In many steel melting processes the dephosphorization reaction approaches equilibrium. Favourable conditions for the reaction are produced in the open-hearth when phosphoric iron is being treated by the scrap-ore process during melt down and the thermodynamics of the dephosphorization of iron by slags of the system  $\text{CaO} - \text{FeO} - \text{SiO}_2 - \text{P}_2\text{O}_5$  are therefore of interest for improving melting conditions. The authors now describe an investigation which had the object of determining the influence of  $\text{SiO}_2$  and  $\text{P}_2\text{O}_5$  when present together in basic slags on the change in the thermodynamics functions of the phosphorus reaction. The successive saturation method previously described by the authors (Refs. 5 and 6) was used, which enables the temperature dependence of the phosphorus partition coefficient for a slag of a given composition to

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SOV/24-58-10-17/34

Thermodynamics of the Dephosphorization Reaction of Liquid Iron with Four-Component Open-Hearth Type Slags

be determined. The distribution was found by using the radioactive phosphorus isotope  $P^{32}$ . Both synthetic and melting slags were investigated. Fig.1 shows the influence of temperature and duration of heating of the slag/metal system on the transfer of phosphorus and Fig.2 the dependence of the logarithm of the partition coefficient on the reciprocal of the temperature for the various slags investigated (compositions tabulated). The results of calculations of  $\Delta H$  and  $\Delta S^0$  are shown in Fig.3 as functions of the  $SiO_2$  - percentage. The authors discuss the results and show (Fig.4) that the data of various investigators agree with the relation found by them for the entropy-change. They conclude that the heat content change associated with the reaction



is independent of slag composition over a wide range of concentration; this indicates the existence of stable ionic

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Thermodynamics of the Dephosphorization Reaction of Liquid Iron with  
Four-Component Open-Hearth Type Slags

groupings which can be considered as silicophosphates. The partition of phosphorus between metal and slag for the system investigated is almost entirely determined by the entropy change of the phosphorus reaction, which depends on the slag composition; when slag and metal temperatures differ it is the latter that determines the phosphorus partition equilibrium. There are 5 figures, 1 table and 13 references, 7 of which are Soviet, 3 English and 3 German.

SUBMITTED: September 30, 1957.

Card 3/3

ATTOR:

Overman, L. A.

107/32-24-8-1/43

TITLE:

Attempts to Study Iron Metallurgy With Radioactive Isotopes  
(Obopye izucheniya radioaktivnykh izotopov v chernoy me-  
tallurgii)

SYNOPSIS:

Izvestiya Akademii Nauk, 1952, Vol. 24, Nr 3, pp. 915-921 (USSR)

ABSTRACT:

The experiments mentioned above were concerned with studying the production of molten steel, and were methodically divided into three main groups. The first group of experiments involved the use of radioactive isotopes as tracers. Investigations concerned with non-metallic inclusions in steel were part of this group and were carried out in the Beloretsk and Magnitogorsk metallurgical Kombinats. (**Kuznetskiy** and **gorokiy metallurgicheskii kombinat**), and the factories of Chelyabinsk, Dnepropetrovsk, "Dneprostal", "Dnepropetrovsk", and "Dneprostal", and other institutions. Also included in this group was the determination of the impurities in steel by using sulfur. Determinations of this kind were carried out in the Beloretsk Metallurgic i Kombinats (Beloretskiy metallurgicheskii kombinat), in the "Gomorkzhstal" factory,

2

DOV/34-24-3-1-1-3

Attempts to Study Iron Metallurgy with Radioactive Isotopes

and in the metallurgical factory Leningrad (Stalinskiy metallurgicheskiy zavod). Studies on the kinetics of crystallization of steel ingots were carried out at the "Azovstal'" factory. The methods were used in the investigations on the slag-forming process. With one method the activity of the slag sample was measured, and the time for the formation of the liquid phase in the radioactively-tagged layer of the slag formation was noted. The second method was that of isotope dilution. The Moscow Institute for Steel (Moskovskiy institut stali) in conjunction with Silyuzhrud successfully began the working-out of the express-method for determining the compound solid phases. Many interesting results of the study of the diffusion of elements in molten slag were obtained. These were obtained at the Moscow Institute for Steel, the Central Scientific Institute (Odesk'iy politekhnicheskii institut), and the Institute for Metal Physics (Institut metallofiziki AN SSSR).

Card 2/2

AUTHOR: Shvartsman, L. A., Doctor of Chemical Sciences. 30-1-13/39

TITLE: The Practice of the Application of Isotopes for Technical Purposes (Iz praktiki primeneniya izotopov v tekhnike).

PERIODICAL: Vestnik AN SSSR, 1958, Vol. 28, Nr 1, pp. 79-83 (USSR)

ABSTRACT: The majority of reports delivered at the Paris Conference in 1957 dealt with problems of metallurgy. The Polish authors T. Mal'kevich and R. Vuzatovskiy used the radioactive isotopes Fe<sup>59</sup> for the explanation of the distribution of non-metallic inclusions in a steel block, which get into the liquid metal during casting from the refractory materials. For this purpose iron oxide which was enriched by Fe<sup>59</sup> was introduced into the raw clay from which the bricks for the lining of the casting device were made. After casting the ingots and blooms were autoradiographed, and besides the radioactive intensity of radiation of the metal was measured. These experiments were also carried out with various refractories in order to determine their influence. The Soviet metal experts V. T. Borisov, V. M. Golikov, B. Ya. Lyubov, and G. V. Shcherbedinskiy in their report dealt with problems of diffusion in real metals, which have a polycrystalline structure. A. A. Zhukhovitskiy, M. Ye. Yanitskaya, and A. D. Sotskov reported on the results of the

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The Practice of the Application of Isotopes for Technical Purposes.

30-1-13/39

application of radioactive isotopes for the solution of certain problems of the diffusion theory. They developed a method which makes it possible to measure the diffusion- and thermodynamic characteristics of metallic mixed crystals simultaneously. The author described the methods of research by means of radioactive isotopes of the equilibrium of the distribution of elements between liquid iron and slags. O. S. Bogdanov and his collaborators described the methods of the application of radioactive isotopes for the investigation of processes of flotation and ore enrichment. The flotoreagents were marked by radioactive isotopes of sulphur, carbon, phosphorus, copper, iron, zinc, and calcium. Great scientific and practical interest was aroused by the problem of the solubility of slightly volatile substances in steam under high pressure: a report on this subject was delivered by M. A. Styrikovich. A. I. Veynik spoke about the application of isotopes for the investigation of heat- and mass transfer for the development of rational methods of drying porous materials. The conference showed that in the USSR and in other countries increased attention is being paid to the determination of new methods of using radioactive isotopes, both in industry and in agriculture, and that

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The Practice of the Application of Isotopes for Technical  
Purposes.

30-1-13, '39

this is done not to the least extent because modern atomic in-  
dustry is able to supply enormous quantities of these substance-  
es every day.

AVAILABLE:

Library of Congress

1. Isotopes-Applications

Card 3/3

SOV/ 20-120-3-45/67

AUTHORS: ~~Shvarteman, L. A.~~, Osipov, A. I., Surov, V. F.,  
Sazonov, M. L., Telesov, S. A., Ofengenden, A. M.

TITLE: On the Equilibrium of Sulfur Distribution Between Metal and  
Slag in Open-Hearth Furnaces (O ravnovesii raspredeleniya  
sery mezhd metallom i shlakom v martenovskikh pechakh)

PERIODICAL: Doklady Akademii nauk SSSR, 1958, Vol. 120, Nr 3, pp.599-604  
(USSR)

ABSTRACT: In the analysis of the desulfurization process in such furnaces  
a clearing up of the dependence of the equilibrium coefficient  
of the sulfur distribution on the slag composition  
and on temperature is primarily necessary. If this is known,  
that minimum limit-concentration of sulfur in the metal can  
be estimated, which can be reached at optimum kinetic conditions  
with the respective slag composition. The difference  
between the actually observed and the equilibrium coefficient  
of the sulfur distribution is apparently conditioned  
by the insufficient velocity of mass transfer in the system  
slag-metal. From a thermodynamical point of view the basicity

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SOV/20-120-3-45/67

## On the Equilibrium of Sulfur Distribution Between Metal and Slag in Open-Hearth Furnaces

of the slag is decisive for the desulfurization. Contrary to current opinion an increase of the concentration of ferrous oxide does not essentially impair the thermodynamical conditions of steel desulfurization in slags of the Siemens-Martin type. At the same time an increase of the said concentration leads to a reduction of the viscosity of the slag and accelerates the processes of mass transfer in it. Fig 1 shows the values of the sulfur distribution coefficients in dependence upon  $\Delta$  (difference between the mole-number of the basic and the acidous oxides contained in 100 g of slag = a measure of the basicity of the slag according to Grant and Chipman, Ref 1). From this the following fundamental conclusions can be drawn: 1) During the melting period the sulfur content in the slag exceeds the value corresponding to the equilibrium with the metal. This circumstance is caused by the transition of the sulfur from the furnace atmosphere into the slag. The transition of the sulfur from the slag to the metal proceeds slowly, its content, in the metal, however, rises (Fig 1). Moreover, the sulfur transition to the metal is chemically conditioned by

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SOV/20-120-3-45/67

On the Equilibrium of Sulfur Distribution Between Metal and Slag in Open-  
 Hearth Furnaces

the composition of the just formed slag. Then the slag is acidous. The  $\Delta$ -values are negative (Fig 1) and the values of the equilibrium coefficients are very small. Figure 1 shows that during the melting period the desulfurization tends towards equilibrium along two ways: a) By the passage of sulfur from the slag to the metal and b) By the continuous change in the amount of slag and its composition. An increase in the amount of slag reduces the sulfur concentration, whereas an increase of the basicity increases the equilibrium coefficient of the distribution. In order to guarantee a combination of thermodynamic and kinetic conditions favorable to a successful desulfurization, such a slag regime must be maintained, in which a) The silicon content in the slag is kept low if possible during the entire melting process, and b) The slag is kept in a sufficiently liquid state. This is achieved by the introduction of liquefying additions, such as agents containing ferrous oxide. There are 2 figures and 2 references, 1 of which is Soviet.

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SOV/20-120-3-45/67

On the Equilibrium of Sulfur Distribution Between Metal and Slag in Open-Hearth Furnaces

ASSOCIATION: Tsentral'nyy nauchno-issledovatel'skiy institut chernoy metallurgii  
(Central Scientific Research Institute of Ferrous Metallurgy)  
Stalinskiy metallurgicheskiy zavod  
(Stalino Metallurgical Plant)

PRESENTED: January 9, 1958, by G. V. Kurdyumov, Member, Academy of Sciences, USSR

SUBMITTED: January 9, 1958

1. Open hearth furnaces--Performance
2. Sulfur--Determination
3. Steel--Quality control
4. Slags--Properties

Card 4/4

18(3)  
 AUTHORS: Petrova, Ye. F., Lapshina, M. I., Shvartsman, L. A. SOV/20-121-6-19/45  
 TITLE: The Solubility of Carbon in Alpha-Iron (Rastvorimost' ugleroda v al'fa-zheleze)  
 PERIODICAL: Doklady Akademii nauk SSSR, 1958, Vol 121, Nr 6, pp 1021-1024 (USSR)  
 ABSTRACT: The authors developed a thermodynamical method for the immediate determination of the concentration of carbon in the solid solution. By combination with other data, the solubility of carbon in ferrite (in the equilibrium with cementite at low temperatures and also in equilibrium with  $\gamma$ -iron at higher temperatures) was calculated. The method investigated in this paper is characterized by the fact that the content of carbon in the iron may be determined without a chemical analysis. The carrying out of the measurements and the measuring apparatus are discussed in short. These experiments gave a linear dependence of  

$$r = \frac{P_{CO}^2}{P_{CO_2}} \text{ on } [\% C] \alpha \cdot P_{CO} \text{ and } P_{CO_2} \text{ denote the partial pressures of CO and CO}_2 \text{ in the equilibrium and } [\% C] \text{ denotes}$$

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The Solubility of Carbon in Alpha-Iron

SOV/20-121-6-19/45

the content of carbon in iron (percent by weight). Therefore the equilibrium constant  $K_{\alpha} = \frac{p_{CO}^2}{p_{CO_2}} [\% C]_{\alpha}$  does not depend on the concentration of carbon.  $K_{\alpha}$  was measured in the temperature interval 700 - 890°. In a diagram (Fig 2), the results of these measurements are given in the coordinates  $\lg K_{\alpha}$  and  $(1/T)$ . The experimental points agree well with a straight line which satisfies the equation  $\lg K_{\alpha} = -(3240/T) + 5,13$ . Therefore, the reaction  $C + CO_2 \rightleftharpoons 2CO^{\alpha}$  has a negative Joule effect, the value of which amounts to 14820 cal/mol. The above-discussed results may be used for the determination of the boundaries of the  $\alpha$ -phase in the iron-carbon system. First, the manner of determining the solubility of carbon below eutectoid temperature is discussed. After some steps, the following expression is found for the solubility of carbon in  $\alpha$ -iron:  $\lg [\% C]_{\alpha}^H = -(4509/T) - 2,25 \cdot 10^{-4} T + 3,22$ .

The results of the calculations carried out by means of these equations are given in a table. According to these results, the solubility of carbon in  $\alpha$ -iron at the eutectoid temperature is very similar to 0,030 weight %. 2 other diagrams show

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The Solubility of Carbon in Alpha-Iron

SOV/20-121-6-19/45

the data concerning the solubility of carbon, found by measuring internal friction. Also these results agree satisfactorily with the generally accepted values. The results obtained with respect to the solubility of carbon seem to be more reliable than those found by the method of internal friction. The results of this investigation may be used for the calculation of the concentrations of carbon in  $\alpha$ -iron in equilibrium with austenite at temperatures above eutectoid temperature. There are 3 figures, 1 table, and 8 references, 1 of which is Soviet.

ASSOCIATION: Institut metallovedeniya i fiziki metallov Tsentral'nogo nauchno-issledovatel'skogo instituta chernoy metallurgii (Institute of Metallography and Physics of Metals of the Central Scientific Research Institute of **Ferrous Metallurgy**)

PRESENTED: April 24, 1958, by G. V. Kurdyumov, Academician

SUBMITTED: April 21, 1958

Card 3/3



SHVARTSMAN, L. A.

*L. A. Shvartsman*

Л.А.Шварцман  
НЕКОТОРЫЕ ВОПРОСЫ ТЕРМОДИНАМИКИ  
ЖЕЛЕЗОУГЛЕРОДИСТЫХ РАСПЛАВОВ

Theoretical Principles of Metallurgical Processes, publ. by Inst.  
Metallurgy Im. A.A. Baykov, Acad. Sci. USSR, Moscow 1959.

(reports of 5th Conference on Physical Chemical Principles for the  
Production of Steel, Moscow, 1959.)

SHVARTSMAN, L.A.

SAZDROV, N.I.; SHVARTSMAN, L.A.

Distribution of elements of the 5th group of the periodic  
table between iron - iron based alloys.

report submitted for the 5th Physical Chemical Conference on  
Steel Production.

MOSCOW 30 JUN 1958

SHVARTSMAN, L. A.

18(0) PHASE I BOOK EXPLOITATION SOV/2125  
 Tsentrallyy nauchno-issledovatel'skiy institut Chernoy metallurgii.  
 Institut Metallovedeniya i fiziki metallov  
 Problemy metallovedeniya i fiziki metallov (Problems in Physical Metallurgy and Metallophysics) Moscow, Metallurgizdat, 1959. 540 p. (Series: Itz: Sbornik trudov, 6) Errata slip inserted. 3,600 copies printed.  
 Additional Sponsoring Agency: USSR Gosudarstvennaya planovaya komissiya  
 Ed. of Publishing House: Ye. M. Berlin; Tech. Ed.: P. G. Kalent'yev; Editorial Board: D. S. Kacemetskaya, B. Ya. Lyubov (Resp. Ed.), Ye. Z. Spektor, L. M. Uvarkiy, L. A. Shvartsmann, and V. I. Malkin.  
 PURPOSE: This book is intended for metallurgists, metallurgical engineers, and specialists in the physics of metals.  
 COVERAGE: The papers in this collection present the results of investigations conducted between 1954 and 1956. Subjects covered include crystallization of metals, physical methods of influencing the processes of crystallization, problems in the physical chemistry of metallurgical processes, development of new methods and equipment for investigating metals, and production control. References follow each article.  
 TABLE OF CONTENTS:  
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covered include crystallization of metals, physical methods of influencing the processes of crystallization, problems in the physical chemistry of metallurgical processes, development of new methods and equipment for investigating metals, and production control. References follow each article.

# PART I. CRYSTALLIZATION OF METALS

Osipov, A. I., L. A. Shvartsmann, V. Ye. Iudin, and M. I. Sazonov. On the Uniform Distribution of a Small Addition in the Slag Furnace During the Production of Steel in a 350-ton (Open-hearth) Furnace 318  
 The distribution process was studied with the use of a radioactive isotope (Ca<sup>45</sup>). It was shown that the process of diffusion of a substance in slag takes place at a considerably slower rate than in metal.

Shvartsmann, L. A., A. I. Osipov, V. I. Alekseyev, V. P. Surov, M. I. Sazonov, M. I. Bul'bul', S. A. Telesov, A. M. Skrabatsov, A. M. Orengeiden, L. O. Gol'denshteyn, and P. P. Svi-idenko. An Investigation of the Kinetics of Scrap Melting in the Scrap-ore Process 326  
 A method for determining the speed of melting scrap in an open-hearth furnace in the scrap-ore process was developed on the basis of this investigation. The method is based on "isotopic dilution" using radioactive cobalt. It was shown that the melting speed depends on the duration of the pig iron pouring process and carbon content in the bath.

Stupar', S. M. Investigation of the Transfer of Sulfur from the Gas Phase to the Bath in the Basic Open-hearth Furnace 344  
 The transfer of sulfur from the gas phase to the bath takes place most intensively during the loading of the metallic portion of the charge. The speed of sulfur absorption during this period is 17-25 percent per hour, during preheating 8-11 percent, and during final melting 3-7.5 percent. Percentage is based on the sulfur content in the metal.

Petrov, Ye. P., and L. A. Shvartsmann. Effect of Alloying Elements on the Thermodynamic Activity of Carbon in Cast Iron 259  
 It is shown that the activity of carbon in cast iron containing additions of Mn, Cr, V, and Ti is considerably higher than in non-alloyed cast iron. This is considered in relation to the bond strength of carbon dissolved in cast iron. It is essentially increased by the introduction of carbon-forming elements.

Malkin, V. I., and L. A. Shvartsmann. Change in the Transport Number of the  $Fe^{2+}$  Ion in Fluxes of Molten Silicates 311  
 Malkin, V. I., V. V. Podgigayev, S. P. Kholobov, and L. A. Shvartsmann. The Effect of an Electric Current Passed Through the Pig-metal Boundary in the Desulfurization Process of Pig Iron 312

24(8)

PHASE I BOOK EXPLOITATION

SOV/2117

Soveshchaniye po eksperimental'noy tekhnike i metodam vysokotemperaturnykh issledovaniy, 1956

Experimental'naya tekhnika i metody issledovaniy pri vysokikh temperaturakh; trudy sovetskikh i inostrannykh nauchnykh i inzhenernykh uchenykh. Konferentsiya po eksperimental'noy tekhnike i metodam issledovaniy pri vysokikh temperaturakh. Moscow, AN SSSR, 1956. 789 p. (Series: Akad. nauch. SSSR. Institut metallurgii. Komissiya po fiziko-khimicheskim osnovam proizvodstva stali) 2,200 copies printed.

Resp. Ed.: A.M. Samarin, Corresponding Member, USSR Academy of Sciences; Ed. of Publishing House: A.L. Bankovskiy.

PURPOSE: This book is intended for metallurgists and metallurgical engineers.

COVERAGE: This collection of scientific papers is divided into six parts: 1) thermodynamic activity and kinetics of high-temperature processes; 2) constitution diagram studies; 3) physical properties of liquid metals and alloys; 4) new analytical methods and production of pure metals; 5) pyrometry, and 6) general questions. For more specific coverage, see table of contents.

# TABLE OF CONTENTS:

## I. DETERMINATION OF THERMODYNAMIC ACTIVITY AND METHODS OF INVESTIGATING THE KINETICS OF HIGH-TEMPERATURE PROCESSES

Gel'd, P.V. Methods of Investigating the Kinetics and Equilibrium Characteristics of Certain Heterogeneous Reactions 5  
The kinetics are investigated by: 1) studying the change in weight of condensed reagents with time; 2) studying the change in weight of condensed reagents with time; 3) other methods (thermogravimetric, dilatometric, electrical, and magnetic). Equilibria are investigated by: 1) static methods and dynamic methods, circulation methods, study of a saturation of condensed phases, and contraction methods; 2) dynamic methods (jet method, control of pressure, thermal methods, and study of vaporization rate).

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SOV/2117

Experimental Techniques and Methods (Cont.)

Shuritsman, L.A. Method of Determining Thermodynamic Activity in Molten Solutions 54  
Thermodynamic activity was determined on the basis of the following: measurement of vapor pressure, chemical equilibrium method, solubility data, data on chemical equilibrium of solutions in the presence of gaseous mixtures, measurement of the electromotive force of voltaic cells, and data on the distribution of the liquid phases.

Petrova, Ye.P., and L.A. Shuritsman. Effect of Alloying Elements on the Thermodynamic Activity of Carbon in Gamma Iron 73  
A method was developed for determining the thermodynamic activity of carbon in solid solutions. Data were obtained on the effect of additions of manganese, chrome, vanadium, and titanium on the activity of carbon in gamma iron. All these elements markedly decrease the activity of carbon in gamma iron. The activity of carbon in gamma iron in alloys with nonalloyed austenite. This indicates that the bond strength of carbon dissolved in gamma iron is considerably increased upon introduction of carbon forming elements into a solid solution. The strongest effect on the activity of carbon, determined by the position of the investigated elements in the periodic table, was produced by titanium and the weakest by manganese. The quantitative difference in the effect of titanium, vanadium, and chrome is small and approaches the accuracy of the measurements.

SOV, 180-59-1-5/29

AUTHORS: Mogutnov, B.M., Perevalov, N.N. and Shvartsman, L.A.  
(Moscow)

TITLE: Influence of Calcium Oxide on the Distribution of Tungsten  
between Liquid Iron and Slag (Vliyaniye okisi kal'tsiya  
na raspredeleniye vol'frama mezhdz zhidkim zhelezom i  
shlakom)

PERIODICAL: Izvestiya Akademii Nauk SSSR, Otdeleniye tekhnicheskikh  
nauk, Metallurgiya i toplivo, 1959, Nr 1, pp 22-28 (USSR)

ABSTRACT: The object of the work described was to study the  
behaviour of tungsten in oxide melts at high temperatures,  
especially to obtain accurate data on the distribution of  
the element between iron and slag in relation to thermo-  
dynamic conditions. A successive saturation method,  
described by Shvartsman and others (Refs 1-3) was used.  
In this small portions of a previously prepared slag  
containing a radioactive isotope of the element concerned  
are added to the iron at a constant temperature until  
further addition produces no further increase in the  
radioactivity of the iron. The distribution coefficient  
is calculated from the radioactivities of metal and slag.  
The isotope (W185) was added to the melted slag in an  
induction-heated iron crucible in the proportion of

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SOV/180-59-1-5/29

## Influence of Calcium Oxide on the Distribution of Tungsten between Liquid Iron and Slag

50 mg (activity 1 millicurie) per 400 g of slag, which was kept molten long enough to allow complete oxidation and mixing. About 50 g of iron (electrolytic) were used, metal temperature being measured with a micro-optical pyrometer and kept constant. Fig 3 shows the count for metal samples at temperatures of 1600, 1640 and 1700°C. Results were reproducible even when equilibrium was approached from different directions (ie with excess or with deficiency of tungsten in the iron). The heat-content and entropy changes associated with the transfer of 1 g atom of tungsten from iron into slag were calculated from the distribution coefficient values at different temperatures (Fig 4 shows the linear relations between the logarithms of the coefficient and  $10^4/(\text{absolute temperature})$ ). With a slag consisting exclusively of iron oxides the heat-content and entropy changes were 14800 cal and 3.84 cal/degree g-atom, respectively. With lime-containing slags the heat-content change is greater, reaching (Fig 5) a value of 41000 cal for a slag with a molar fraction of CaO of 0.40 (all slag iron assumed to be

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SOV/180-59-1-5/29

Influence of Calcium Oxide on the Distribution of Tungsten between Liquid Iron and Slag

in the form of  $\text{FeO}$ ). The authors discuss their own and published results (Refs 5 and 6) and estimate the heat of mixing of  $\text{WO}_3$  with ferruginous limey slag. They conclude that this oxide has a pronounced acidic nature, and that with increasing basicity of open-hearth slags the oxidation of tungsten from liquid steel should increase.

Card 3/3 There are 6 figures, 2 tables and 7 references, 3 of which are Soviet, 3 English and 1 German.

SUBMITTED: March 1, 1958

SOV/180-59-2-2/34

AUTHORS: Travin, O.V. and Shvartsman, L.A. (Moscow)

TITLE: Dephosphorization of Pig Iron with Solid Mixtures  
(Defosforatsiya : chuguna tverdymi smesyami)

PERIODICAL: Izvestiya Akademii Nauk, SSSR, Otdeleniye Tekhnicheskikh  
Nauk, Metallurgiya i Toplivo, 1959, Nr 2, pp 8-12 (USSR)

ABSTRACT: The authors state that, unlike desulphurization, the external dephosphorization of pig iron has received little research attention and is not applied in practice. A difficulty of such a process is that the phosphorus has to be oxidized while preserving a high concentration of carbon, (silicon, which gives rise to additional difficulties, has to be oxidized before dephosphorization). The object of the work described was to see whether solid lime-ferric oxide mixtures could be used for such dephosphorization. The mixtures with various lime : oxide ratios were made in tablets weighing 200 - 2500 mg, which were placed on the surface of molten iron containing radioactive phosphorus P<sup>32</sup>. The initial phosphorus content of the iron was 0.005 - 0.737%. Temperatures (1200 - 1600 °C) were measured with an optical pyrometer. From measurement of the radioactivities of the top and

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SOV/180-59-2-2/34

Dephosphorization of Pig Iron with Solid Mixtures

bottom faces of the tablet the thickness of the phosphorus-containing layer (defined as the thickness over which the phosphorus concentration changes ten-fold) was determined. The authors admit the inaccuracies of this procedure. Loss in weight of the tablets always took place, due to reduction of their iron oxide. It was found (Table 1) that both loss in weight and quantity of phosphorus transferred to the tablet were approximately proportional to the tablet/metal contact area. The tablets were 50% CaO, 50% Fe<sub>2</sub>O<sub>3</sub>, the temperature 1265°C and initial phosphorus-content 0.017%. The influence of temperature was studied using 65% CaO, 35% Fe<sub>2</sub>O<sub>3</sub> in tablets weighing 2000 mg with iron (0.02% P) weights of 500 g. The results (Table 2) indicated the advantage of low temperatures. Further tests at about 1235°C showed that there is an optimal contact time. The authors discuss the kinetics of the process, and the influence of the effective diffusion coefficient of the phosphorus. Special experiments at 1200-1300 °C showed that this does not exceed 10<sup>-7</sup> cm<sup>2</sup>/sec, indicating that a layer of phosphates containing over 20% phosphorus is formed on the surface of the slag particles

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SOV/180-59-2-2/34

Dephosphorization of Pig Iron with Solid Mixtures

for the whole iron phosphorus-content range studied. The authors have also calculated from their experimental results for 27.2% lime tablets the mean  $P_2O_5$  content in the phosphorus-containing layer, the weight of the layer and the quantity of phosphorus in the tablets, (Table 4). The general conclusion is that  $CaO-Fe_2O_3$  solid slags can be used for dephosphorizing silicon-free iron. There are 4 tables and 2 English references.

SUBMITTED: July 2, 1958

Card 3/3

SOV/180-59-3-7/43

AUTHORS: Sazonov, M.L. and Shvartsman, L.A. (Moscow)

TITLE: Distribution of Niobium Between Iron and Ferruginous Slag

PERIODICAL: Izvestiya Akademii nauk SSSR, Otdeleniye tekhnicheskikh nauk, Metallurgiya i toplivo, 1959, Nr 3, pp 34-36 (USSR)

ABSTRACT: The authors describe their investigation of the behaviour of niobium in iron/ferruginous slag. Radioactive  $Nb^{95}$  was used to determine the niobium-content of iron after it had been kept in contact with the slag. Flakes of electrolytic iron were moistened with  $Nb^{95}$ -containing aqueous  $Nb_2(C_2O_4)_5$  and melted in a neutral atmosphere. The logarithm of the distribution coefficient was found, for the temperature range 1535 to 1740°C, to be equal to  $(70500/4.575T) - 3.18$  where T is the absolute temperature. The linearity of the relation is shown graphically, the heat-content change associated with the transfer of 1 g atom of niobium from metal to slag being 70500 cal. Good agreement for this with the calculated value (72.250 cal/g atom) confirms that in slag niobium is in the form  $Nb_2O_5$  and indicates that both in slag and metal the heats of mixing are low. From their own and published (Ref 4)

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SOV/180-59-3-7/43

Distribution of Niobium Between Iron and Ferruginous Slag

data the authors calculate the value of the equilibrium constant for the reaction  $2\text{Nb}(\text{in Fe}) + 5(\text{FeO}) = (\text{Nb}_2\text{O}_5) + 5\text{Fe}$  at  $1873^\circ\text{K}$  to be  $3.6 \times 10^{13}$ . There is 1 figure and 4 references, 3 of which are Soviet and 1 English.

SUBMITTED: February 25, 1959

Card 2/2

TOMILIN, I.A., kand.tekhn.nauk; SHVARTSMAN, L.A., doktor khim.nauk

Effect of silica, calcium oxide and sodium oxide on the distribution of sulfur and phosphorus between iron and iron slag.

Probl.metalloved.i fiz.met. no.6:199-220 '59. (MIRA 12:8)  
(Iron--Metallurgy) (Slag) (Thermochemistry)

KOZHEVNIKOV, I.Yu., kand.tekhn.nauk; SHVARTSMAN, L.A., doktor khim.nauk

Effect of alkaline earths on the equilibrium of the iron de-phosphorization reaction. Probl.metalloved.i fiz.met. no.6:221-258  
'59. (MIRA 12:8)

(Iron--Metallurgy) (Alkaline earths) (Thermochemistry)

S/137/62/000/005/005/150  
A006/A101

AUTHORS: Petrova, Ye. F., Shvartsman, L. A.

TITLE: The effect of alloying elements upon the thermodynamic activity of carbon in gamma-iron

PERIODICAL: Referativnyy zhurnal, Metallurgiya, no. 5, 1962, 9, abstract 5A58  
("Sb. tr. In-t metallov. i fiz. metallov Tsent. n.-i. in-ta chernoy metallurgii", 1959, v. 6, 259-292)

TEXT: To determine the C content in  $\gamma$ -Fe directly during the experiment without removing the specimen from the unit, the circulation method was employed that had been developed by M. I. Temkin and his collaborators ("Zh. fiz. khimii", 1949, v. 23, 695). The equilibrium of the reaction  $C(\text{dissolved in Fe}) + CO_2 = 2CO$  was attained as a result of pure CO circulation in a closed, preliminarily evacuated circuit, into which a carbonfree Fe sample was placed at constant controlled temperature. After the equilibrium had been attained,  $CO_2$  was frozen out, CO was evacuated and partial  $CO_2$  pressure was determined by measurement with the Mac-Leod manometer. The weight of C dissolved in the Fe-specimen was determined from the amount of  $CO_2$ . Greater CO pressures were measured with the

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5(2,4)

AUTHORS:

Perevalov, N. N., Mogutnov, B. M.,  
Shvartsman, L. A.

SOV/20-124-1-42/69

TITLE:

The Effect of the Basicity of Slag on the Oxidation of Chromium  
Subgroup Elements Dissolved in Liquid Iron (Vliyaniye  
osnovnosti shlaka na okisleniye elementov podgruppy khroma,  
rastvorenykh v zhidkom zheleze)

PERIODICAL:

Doklady Akademii nauk SSSR, 1959, Vol 124, Nr 1, pp 150-152  
(USSR)

ABSTRACT:

The oxidation of the elements dissolved in iron is to a considerable extent due to the interconnection between the acid - basic properties of the forming oxides and the basicity of slag. Slags containing only iron oxides (iron containing slags) were regarded as neutral by the authors. They were regarded as the basis to which calcium oxide and silica, the most typical oxides occurring in slags with respect to their acid - basic properties, were added. The authors investigated the dependence of the distribution coefficient  $L$  of the corresponding element at low concentration between iron and slag in dependence on the composition of slag.  $L$  was determined

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The Effect of the Basicity of Slag on the  
Oxidation of Chromium Subgroup Elements Dissolved in Liquid Iron

SOV/20-124-1-42/69

according to the method applied in reference 1 with the help of radioactive isotopes  $\text{Cr}^{51}$ ,  $\text{Mo}^{99}$  and  $\text{W}^{185}$ . The results obtained show that in all cases the dependence of L on temperature is satisfactorily expressed by the equation

$$\lg L = \frac{A}{T} + B \quad (1). \quad A \text{ denotes the heat effect of the reaction}$$

$$\left( A = - \frac{\Delta H}{4.573} \right), \text{ and the constant } B \text{ denotes the}$$

variation of entropy. The composition of the investigated slags is given in table 1. L as well as A and B depend but very little on the concentration of the calcium oxide in the case of chromium oxidation. The presence of  $\text{SiO}_2$  in the iron containing

slag means an increase of the heat of reaction of chromium oxidation.  $\text{Cr}_2\text{O}_3$  is a basic oxide (Ref 3). The authors state

that this oxide in the slag melts is to be regarded as a weak base. It can be seen (Table 1) that in the case of the introduction of calcium oxide into the slag L is doubled and trebled compared to the iron containing slag. Also the heat effect of the reaction increases. The introduction of silica

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The Effect of the Basicity of Slag on the  
Oxidation of Chromium Subgroup Elements Dissolved in Liquid Iron

SOV/20-124-1-42/69

has a contrary effect; the heat effect remains almost unchanged. This fact makes the conclusion possible that the decrease of  $L$  is caused by the entropy component of free energy. The main difference between molybdenum oxidation and chromium is therefore the fact that in the latter case a higher oxide is formed which clearly behaves like an acid in the slag. In the case of tungsten oxidation  $\text{CaO}$  has a rather increasing effect upon  $L$  and the heat of reaction (Ref 4). They are both reduced by  $\text{SiO}_2$ . Thus, the balance of the oxidation reaction of molybdenum and tungsten which form in the slag higher oxides with marked acid properties - depends considerably upon basicity. With respect to chromium this is the case only to a negligible extent. There are 1 table and 4 references, 3 of which are Soviet.

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The Effect of the Basicity of Slag on the SOV/20-124-1-42/69  
Oxidation of Chromium Subgroup Elements Dissolved in Liquid Iron

ASSOCIATION: Institut metallovedeniya i fiziki metallov Tsentral'nogo  
nauchno-issledovatel'skogo instituta chernoy metallurgii  
(Institute of Metallography and Metal Physics of the Central  
Scientific Research Institute of Ferrous Metallurgy)

PRESENTED: August 15, 1958, by G. V. Kurdyumov, Academician

SUBMITTED: August 13, 1958

Card 4/4

80196

S/129/60/000/04/004/020

E073/E535

18.7500

AUTHORS:

Petrova, Ye. F., Candidate of Technical Sciences,  
Lapshina, M. I., Candidate of Chemical Sciences and  
Shvartsman, L. A., Doctor of Chemical Sciences

TITLE:

Influence of Alloying Elements on the Thermodynamic  
Activity and the Solubility of Carbon in  $\alpha$ -iron

PERIODICAL: Metallovedeniye i termicheskaya obrabotka metallov,  
1960, No 4, pp 22-25 (USSR)

ABSTRACT:

Up to now the solubility of carbon in alloyed ferrite has not been determined by thermodynamic methods. In this paper the results are given of the study of the influence of certain alloying elements on the thermodynamic activity and the solubility of carbon in  $\alpha$ -iron. These magnitudes were determined on the basis of equilibrium data measured on mixtures of CO-CO<sub>2</sub> with carbon, which were in the solid solution, using a circulation method described in earlier work of the authors (Ref 1). For comparison a solution of carbon in  $\alpha$ -iron was chosen which did not contain other

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S/129/60/000/04/004/020  
E073/E535

Influence of Alloying Elements on the Thermodynamic Activity and  
the Solubility of Carbon in  $\alpha$ -iron

admixtures. In this case the equilibrium constant of the reaction  $C + CO_2 = 2CO$  does not depend on the carbon concentration in the metal. Equations are derived governing the solubility of carbon in alloys of  $\alpha$ -iron with cobalt, Eqs (12)-(14). By means of these equations, the solubility values were calculated for three alloys with various cobalt contents as a function of the temperature and these are plotted in Fig 1; for comparison the solubility curve for pure ferrite is also plotted in this figure. The presence of manganese in  $\alpha$ -iron reduces the activity of the carbon and consequently the solubility should increase. Assuming that the iron carbide, which is rejected in the studied alloys, does not contain manganese, the solubility of carbon in these alloys can be calculated in the same way as was done for the Fe-Co system; the resulting equations are Eqs (18) and (19). It can be

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Influence of Alloying Elements on the Thermodynamic Activity and the Solubility of Carbon in  $\alpha$ -iron

seen that the addition of manganese to the  $\alpha$ -iron increases its solubility of carbon. Results calculated on the basis of Eq (18) are graphed in Fig 2 (variation of the solubility of carbon in Fe-Mn alloys as a function of the temperature for various manganese contents). The influence of silicon and chromium on the behaviour of carbon in  $\alpha$ -iron was investigated by determining the respective activity coefficients. The results obtained by the authors indicate that cobalt increases the activity of carbon in the  $\alpha$ -iron and this is also the case for silicon. However, carbide forming elements of the transition group Mn and Cr, which interact with iron only slightly, bring about a reduction in the activity of carbon in the  $\alpha$ -iron. In earlier work (Ref 1) the same qualitative results were obtained on the influence of carbide forming elements on the activity

Card 3/4 of carbon in  $\gamma$ -iron.

80196

S/129/60/000/04/004/020  
E073/E535

Influence of Alloying Elements on the Thermodynamic Activity and  
the Solubility of Carbon in  $\alpha$ -iron

There are 3 figures and 2 references, 1 of which is  
Soviet and 1 English.

ASSOCIATIONS: Tsentral'nyy nauchno-issledovatel'skiy institut  
chernoy metallurgii (Central Scientific Research Institute  
for Ferrous Metallurgy) and Vsesoyuznyy zaochnyy  
mashinostroitel'nyy institut (All Union Correspondence  
Mechanical Engineering Institute)

✓

Card 4/4

SAVOST'YANOVA, N.A.; SHVARTSMAN, L.A.

Solubility of vanadium carbide in gamma iron. Fiz. met. i metalloved.  
9 no. 4:515-519 Ap '60. (MIRA 14:5)

1. Institut metallovedeniya i fiziki metallov TSentral'nogo  
nauchno-issledovatel'skogo instituta chernoy metallurgii.  
(Vanadium carbide) (Solutions, Solid)



12.2400  
10 (7), 21 (8)  
AUTHORS:

Sazonov, M. L., Shvartsman, L.A.

68212  
S/C32/60/026/01/025/052  
B010/B001

TITLE:

The Use of Radioactive Isotopes<sup>14</sup> of Arsenic and Niobium for the investigation of Metallurgical Reactions

PERIODICAL:

Zavodskaya laboratoriya, 1960, Vol 26, Nr 1, pp 68 - 71 (USSR)

ABSTRACT:

The authors describe methods which may be used for the investigation of the distribution of niobium and arsenic between an iron melt and the slag. Nb<sup>95</sup> and As<sup>76</sup> were used for the experiments; special attention was paid to their separation from radioactive impurities. 3 g portions of slag powder, saturated with Nb<sup>95</sup>(C<sub>2</sub>O<sub>4</sub>)<sub>5</sub> and dried, were applied to the surface of the molten iron sample in order to investigate the powder by the method of successive saturation. It was found that the radioactive impurities (Ru<sup>106</sup>) of Nb, but not Nb itself, pass over into the iron melt. Thus, a method can be worked out for the purification of Nb<sup>95</sup> from radioactive impurities (Table: Radioactivity of Metal Samples in Equilibrium). Experiments in

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68212

The Use of Radioactive Isotopes of Arsenic and Niobium for the Investigation of Metallurgical Reactions

S/032/60/026/01/023/052  
B01C/BC01

the temperature interval 1535 - 1740°C showed that the temperature function of the distribution coefficient  $L_{Nb}$  obeys an equation according to which 70,500 cal are liberated on oxidation of 1 g-atom Nb (dissolved in iron). Since the distribution coefficient  $L_{As}$  for arsenic is small, the method of sample withdrawal was applied to investigate the equilibrium of arsenic. Special experiments on the effect of radioactive impurities on the determination accuracy of  $L_{As}$  were carried out. The slag was separated from the molten iron containing  $As^{76}$  by "freezing on" to a steel rod. The procedure was frequently repeated and it was found that the radioactive impurities have a greater distribution coefficient than arsenic and thus were successively removed by repeated slag withdrawal (Fig 2). Thus,  $As^{76}$  has to be freed from radioactive impurities before investigations of the As distribution between iron and slag are carried out. It was found that  $L_{As}$  does not depend on the

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68212

The Use of Radioactive Isotopes of Arsenic and  
Niobium for the Investigation of Metallurgical  
Reactions

S/032/60/026/01/025/053  
B010/B001

arsenic concentration in iron and thus it exists in the slag  
as cation  $\text{As}^{3+}$  and not as  $\text{As}_2\text{O}_3$  molecule. Due to the low value  $\gamma$   
of  $L_{\text{As}}$ , arsenic cannot be removed from the molten iron with  
the slag. There are 2 figures, 1 table, and 4 Soviet references.

ASSOCIATION: Tsentral'nyy nauchno-issledovatel'skiy institut chernoy  
metallurgii (Central Scientific Research Institute of Iron  
Metallurgy)

Card 3/3

84702

15.2142

S/020/60/133/006/005/016  
B016/B060

AUTHORS: Alekseyev, V. I., Shvartsman, L. A.

TITLE: The Equilibrium in the System  $V_2C$  —  $H_2$  —  $CH_4$  — V

PERIODICAL: Doklady Akademii nauk SSSR, 1960, Vol. 133, No. 6,  
pp. 1331-1333

TEXT: The authors determined the free formation energy of a vanadium carbide with a composition similar to that of  $V_2C$ , which was in equilibrium with metallic vanadium. Its structure was examined by X-ray structural analysis. The authors studied the equilibrium  
 $V_2C(solid) + 2H_2(gas) = CH_4(gas) + V(solid)$  (2). The equilibrium constant of reaction (2) was determined with the aid of an apparatus illustrated in Fig. 1. The carbide powder investigated was introduced into a quartz tube placed in a furnace. The furnace temperature was adjustable. Hydrogen was allowed to circulate over the powder, and subsequently, an  $H_2$  —  $CH_4$  mixture according to the progressing reaction (2). After

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84702

The Equilibrium in the System  
 $V_2C - H_2 - CH_4 - V$

S/020/60/133/006/005/016  
B016/B060

having obtained equilibrium, the authors burned the hydrogen in tube 2 which contained a copper oxide heated up to 300°C. The steam was frozen out in a liquid-nitrogen trap. For kinetic reasons, methane is not burned over copper oxide at 300°C (Refs. 3,4). The methane pressure was measured by means of a McLeod gauge. Since the reaction equilibrium is markedly shifted toward the left, the partial pressures of methane were very low ( $10^{-3}$  -  $10^{-2}$  torr). In their calculation of  $K_r$  the authors equated the equilibrium pressure of hydrogen (about 190 - 300 torr) to the total pressure in the circulation apparatus. The total pressure was measured with a U-gauge (10) and by a microscopic determination of the level. Fig. 2 shows an X-ray picture of the sample investigated. Two phases are visible on it: metallic vanadium and a carbide with a hexagonal structure. According to Ref. 1, this carbide corresponds to  $V_2C$  as to its composition. The experiments were made between 600° and 1000°C. The equilibrium of reaction (1) was attained between 75 and 20 h depending on the temperature. The experimental results are represented in Fig. 3 as  $\log K_r = f(1/T)$ . The equation of the straight line reads:  $\log K_r = 2201.9/T - 5.823$  (3), and that of the free energy is:

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84702

The Equilibrium in the System  
 $V_2C - H_2 - CH_4 - V$

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$\Delta G_{973-1273^\circ K}^\circ = -10,050 + 26.65 T$  (4). A combination of reaction (2) with that for the methane formation (5) yields:  $2V_{(solid)} + C_{(solid)} = V_2C_{(solid)}$  (7) and  $\Delta G_{973-1273^\circ K}^\circ = -11,500 - 0.49 T$ . The formation heat determined for vanadium carbide is a little lower than the one assumed for VC by an estimation in Ref. 2. This divergence is probably to be explained by the inaccurate determination of  $\Delta H$  for VC. In vanadium-alloyed steels the excess carbide phase approaches the VC composition. The authors finally mention the applications of the above-derived equation. There are 3 figures and 6 references: 3 Soviet, and 2 German.

ASSOCIATION: Tsentral'nyy nauchno-issledovatel'skiy institut chernoy metallurgii (Central Scientific Research Institute of Ferrous Metallurgy)

PRESENTED: March 25, 1960, by G. V. Kurdyumov, Academician

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84702

The Equilibrium in the System  
 $V_2C - H_2 - CH_4 - V$

S/020/60/133/006/005/016  
B016/B060

X

SUBMITTED: March 25, 1960

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S/137/62/000/005/009/150  
A006/A101

AUTHORS: Sazonov, M. L., Shvartsman, L. A.

TITLE: Distribution of elements of the fifth group of a periodic system between iron and ferrous slag

PERIODICAL: Referativnyy zhurnal, Metallurgiya, no. 5, 1962, 14-15, abstract 5A83 (V sb. "Fiz.-khim. osnovy proiz-va stali", Moscow, AN SSSR, 1961, 68-76)

TEXT: The method of radioactive isotopes was used to study the distribution of Sb, As and Nb between Fe and Fe-slag.  $Sb^{124}$ ,  $As^{76}$  and  $Nb^{95}$  were used. Distribution of Sb and As was studied by taking off samples. Coefficient of distribution  $L$  was determined from the frequency recordings of slag and Fe batches. The experiments were carried out at  $1,540 - 1,750^{\circ}C$ . The temperature was measured with a microoptical pyrometer. To reveal the dependence of  $L$  on the concentration of the dissolved substance, experiments were made at  $1,600^{\circ}C$  and variable content of Sb and As. The distribution of Nb was studied by the method of consecutive saturation (RZhMet, 1957, no. 5, 7519)  $lg L_{Sb} = 16,200/4.575 T + 2.80/4.575$  (for  $1,540 - 1,750^{\circ}C$  temperatures);  $lg L_{As} = -26,500/$

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Distribution of elements of the fifth group ...

S/137/62/000/005/009/150  
A006/A101.

$4.575 T + 4.80/4.575$ ;  $\lg L_{Nb} = 70,500/4.575 T - 14.55/4.575$  (for  $1,535 - 1,740^\circ\text{C}$ ). At  $1,600^\circ\text{C}$   $L_{As} \approx 0.01$  and  $L_{Sb} \approx 0.05$  and do not depend on As and Sb concentration in Fe. It is assumed that As and Sb are present in liquid Fe in the form of ions. The value of  $L_{Nb}$  is considerably higher (about  $10^4$ ). From the temperature dependence of  $L$  the authors calculated oxidation heats of elements in liquid Fe and changes of entropy. It is shown that Sb and As oxidation are accompanied by heat absorption (16,200 and 26,500 cal/g-atom respectively) and increased entropy (2.8 and 4.8 cal/degree-g-atom respectively) Nb oxidation is accompanied by heat liberation and decreased entropy (70,500 cal/g-atom and 14.55 cal/degree-g-atom respectively). A comparison of the results obtained with literature data made it possible to assert that Sb and As are present in Fe in trivalent state, and Nb in pentavalent state. Low  $L_{Sb}$  and  $L_{As}$  values are connected with the fact that Sb and As are forming, during oxidation, low stable trioxides with weakly marked acid-basic properties.

A. Panov

[Abstracter's note: Complete translation]

Card 2/2

ZUROV, V.F.; TRAVIN, O.V.; SHVARTSMAN, L.A.

Refining cast iron and steel outside the furnace. *Izv.vys.ucheb.  
zav.; chern.met. 4 no.5:47-49 '61.* (MIRA 14:6)

1. Tsentral'nyy nauchno-issledovatel'skiy institut chernoy  
metallurgii.

(Cast iron--Metallurgy) (Steel--Metallurgy)

21360

S/126/61/011/004/007/023  
E111/E435

15 2220 1273, 1043, 1142

AUTHORS: Alekseyev, V.I. and Shvartsman, L.A.

TITLE: Free Energy of Formation of Some Carbides of Vanadium and Chromium

PERIODICAL: Fizika metallov i metallovedeniye, 1961, Vol. 11, No. 4, pp. 545-550 + 1 plate

TEXT: The authors describe their  $\text{CH}_4/\text{H}_2$  equilibrium studies on the systems  $\text{V}_4\text{C}_3\text{-V}_2\text{C}$  and  $\text{Cr}_{23}\text{C}_6\text{-Cr}$  using a gas-circulation method. Combining these results with those for graphite, they have found the temperature dependence of the free energy of formation from the metals and graphite of  $\text{V}_4\text{C}_3$  and  $\text{Cr}_{23}\text{C}_6$ . In the literature such data for carbides are calculated from thermal values. The authors assume that the free energy of formation of  $\text{VC}_{0.41}$  (called  $\text{V}_2\text{C}$ ) remains constant for its homogeneity range and that the saturated solid solution of carbon in the metal can be denoted as pure metal. Using their previously described (Ref. 1) apparatus and method and published data (Ref. 3) they obtained the following equation for carbon solubility

$$\lg [\% \text{C}] = - \frac{11500}{4.575 T} - 0.61 \quad (3)$$

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S/126/61/011/004/007/023  
E111/E435

# Free Energy of Formation

In the present work, the same method (Ref. 1) was used to find the free energy of formation from the elements of  $V_4C_3$  and  $Cr_{23}C_6$ . The first was prepared by vacuum reaction of  $V_2O_3$  with carbon at 1500 to 1700°C (Ref. 4). Metallic vanadium was added and the mixture was heated to produce a system containing both  $V_4C_3$  and  $V_2C$  over long periods. The  $Cr_{23}C_6$ -Cr material was made by heating lamp black with chromium powder (0.06% C, 0.03 N, 0.06 O, 0.05 Fe, 0.01 W, 0.03 Al) at 1450 to 1500°C in argon for 10 hours. In most experiments equilibrium was approached from the hydrogen side. The kinetics of the  $C + H_2$  reaction was found, in subsidiary experiments, to be unsuitable for producing mixtures permitting an approach from the other side. The equilibrium methane pressure in a closed volume was determined after oxidation of hydrogen over copper oxide at 290 to 300°C and removal of water by freezing in liquid nitrogen. For the reaction  $V_4C_3$  solid +  $2H_2$  gas =  $2V_2C$  solid +  $CH_4$  gas it was found that

$$\Delta G_{973-1223}^0 = -12500(\pm 400) + 28.4(\pm 1.0) T \quad (8)$$

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Free Energy of Formation

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Combination of this with Richardson's equation, for the graphite-hydrogen reaction giving methane

$$\Delta G_{500-2273}^0 = 21550 - 26.16 T \quad (9)$$

gives for the  $2V_2C_{solid} + C_{solid} = V_4C_3$  solid reaction

$$\Delta G_{973-1223}^0 = -9000 (\pm 400) - 2.20 (\pm 1.0) T \quad (11)$$

Combination of this with the equation for  $V_2C$  formation from the elements

$$\Delta G_{973-1273}^0 = -11500 (\pm 600) - 0.5 (\pm 0.6) T \quad (1)$$

gives

$$\Delta G_{973-1223}^0 = -10800 (\pm 500) - 1.1 (\pm 0.7) T \quad (12)$$

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Free Energy of Formation

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for the formation of  $V_4C_3$  from the elements for 1 g atom C. For the reaction  $1/6 Cr_{23}C_6$  solid +  $2H_2$  gas =  $23/6 Cr$  solid +  $CH_4$  gas, the equation is

$$\Delta G_{973-1223^\circ K}^0 = -7900 (\pm 400) + 26.3 (\pm 0.4) T \quad (14)$$

Combination with Eq. (9) gives, for the reaction  $23/6 Cr$  solid +  $C$  solid =  $1/6 Cr_{23}C_6$ ,

$$\Delta G_{973-1223^\circ K}^0 = -13600 (\pm 400) - 0.2 (\pm 0.4) T \quad (16)$$

This indicates a stability lower than that given by Richardson (Ref. 5) but higher than that of either of the vanadium carbides. The latter is anomalous in view of the positions of the elements in the periodic table. The limiting solubility of carbon in solid chromium in equilibrium with  $Cr_{23}C_6$  can be found as for the vanadium system. There are 4 figures, 1 table and 6 references: 4 Soviet and 2 non-Soviet.

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Free Energy of Formation ...

S/126/61/011/004/007/023  
E111/E435

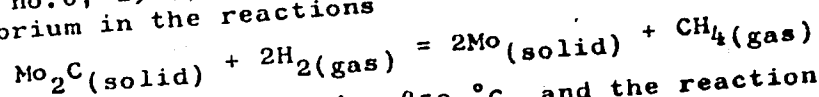
ASSOCIATION: Institut metallovedeniya i fiziki metallov TsNIChM  
(Institute of Science of Metals and Physics of Metals  
TsNIChM)

SUBMITTED: July 14, 1960

Card 5/5

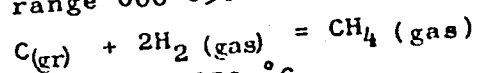
S/180/62/000/006/020/022  
E021/E151

AUTHORS: Alekseyev, V.I., and Shvartsman, L.A. (Moscow)  
TITLE: Free energy of formation of molybdenum carbide  $\text{Mo}_2\text{C}$   
PERIODICAL: Akademiya nauk SSSR. Izvestiya. Otdeleniye  
tekhnicheskikh nauk. Metallurgiya i toplivo, no.6,  
1962, 171-175  
TEXT: The circulation method described earlier (DAN SSSR,  
v.133, no.6, 1960, 1331-1333) was used to investigate the  
equilibrium in the reactions



(2)

in the temperature range 600-850 °C, and the reaction



in the temperature range 700-950 °C.

Pure hydrogen (obtained electrolytically) was used. Molybdenum  
carbide was made by cold pressing molybdenum and carbon powders  
and sintering at 1500 °C for 10 hours in a purified argon

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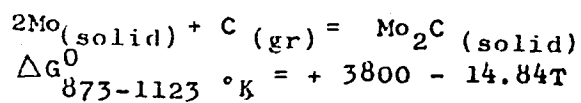
Free energy of formation of ....

S/180/62/000/006/020/022  
E021/E151

atmosphere. For the first reaction the free energy followed the equation

$$\Delta G_{873-1123}^0 \text{ } ^\circ\text{K} = -25350 + 41.0T.$$

The results obtained for the equilibrium in the second reaction . . agreed with data of F.D. Richardson (The thermodynamics of metallurgical carbides and of carbon in iron, J. of Iron and Steel Inst., v.175, 1953, 45). The equation for the free energy of formation of the carbide  $\text{Mo}_2\text{C}$ , calculated from the above, was found to be



There are 1 figure and 2 tables.

SUBMITTED: May 26, 1962

Card 2/2

15.2240

S/020/61/141/002/012/027  
P103/B110

AUTHORS: Alekseyev, V. I., and Shvartsman, L. A.

TITLE: Free energy of formation of manganese carbide,  $Mn_{23}C_6$

PERIODICAL: Akademiya nauk SSSR. Doklady, v. 141, no. 2, 1961, 346 - 348

TEXT: The free energy of formation of lowest-carbon manganese carbide  $Mn_{23}C_6$  was determined, and the equilibrium in the system  $Mn_{23}C_6-H_2-Mn-CH_4$  was studied by a method described earlier (V. I. Alekseyev, L. A. Shvartsman, DAN, 133, no. 6 (1960)).  $Mn_{23}C_6$  was obtained by sintering a mixture of metallic Mn powders and carbon black at 1050°C for 24 hr in argon atmosphere. The x-ray pattern of the sample before and after the experiment showed two phases: (a)  $Mn_{23}C_6$ , and (b) Mn. From the results it is concluded that the equilibrium constant  $K_{eq} = P_{CH_4} / P_{H_2}^2$  of the reaction  $1/6 Mn_{23}C_6(solid) + 2H_2(gas) = 23/6 Mn(solid) + CH_4(gas)$  was determined in the experiments between 650 and 900°C. The function  $\log K_{eq} = f(1/T)$

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00701

S/020/61/141/002/012/027

B103/B110

Free energy of formation...

was found to be linear. Spread of the results is explained by intensive Mn sublimation and condensation on the cold parts of the apparatus. This causes a change in the gaseous phase composition due to  $\text{CH}_4$  and  $\text{H}_2$  adsorption. Furthermore, careful degassing of the sample at the required temperature is impeded by the volatility of Mn. The results were evaluated by the method of least squares, and the equations  $\log K_{\text{eq}923 - 1173^\circ\text{K}} = [4000 (\pm 380)]/T - 6.45 (\pm 0.45)$  and  $\Delta G_{923 - 1173^\circ\text{K}}^\circ = -18300 (\pm 1700) + 29.51 (\pm 2.0) T$  (3) were derived. The combination of Eq. (3) with the equation for the free energy of formation of  $\text{CH}_4$  from C and  $\text{H}_2$  (Ref. 8, see below) gives for the reaction  $23/6 \text{ Mn}_{(\text{solid})} + \text{C}_{(\text{graphite})} = 1/6 \text{ Mn}_{23}\text{C}_6(\text{solid})$  (4):  $\Delta G_{973 - 1173^\circ\text{K}}^\circ = -3300 (\pm 1700) - 3.35 (\pm 2.0) T$  (5). Hence it is concluded that the heat of formation of  $\text{Mn}_{23}\text{C}_6$  (-3300 cal) is very close to that of  $\text{Mn}_3\text{C}$ . From a comparison of thermodynamic data of  $\text{Mn}_{23}\text{C}_6$  (formation under heat generation) with those of  $\text{Mn}_7\text{C}_3$  (Ref. 5, see below) the latter is assumed to be an endothermic compound.

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Free energy of formation...

701  
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Explanation: In the formation of carbides of transition metals of group IV, the d-shell of metal atoms is partly filled with valence electrons of C atoms. The energy of the additional electrons increases during the filling process of d-shell vacancies. Hence, the heat of carbide formation decreases as the degree of d-shell filling increases with increasing atomic number in the order Ti→Ni and also with increasing ratios between the number of C atoms and that of metal atoms in carbides. In the order Ti→Ni, chromium is an exception since the heat of formation of  $\text{Cr}_2\text{C}_6$  (-13,600 cal) exceeds that of  $\text{V}_2\text{C}$  (-11,500 cal). On the basis of this anomaly, the structure of a free Cr atom presumably differs from that of its neighbors Mn and V by containing only one electron on level 4 s (as against 2 with Mn and V). At the same time, the d-shell of a Cr atom contains just as many electrons as the d-shell of an Mn atom. Therefore, it has 2 electrons more than the same shell of a V atom. Hence, it is assumed that the covalent bond in the formation of chromium carbides is possible by coupling one valence electron of C with the 4 s electron of Cr. There are 2 figures and 9 references: 4 Soviet and 5 non-Soviet. The three references to English-language publications read as follows:

Card 3/4

30701

Free energy of formation...

3/020/61/141/002/012/027  
B103/B110

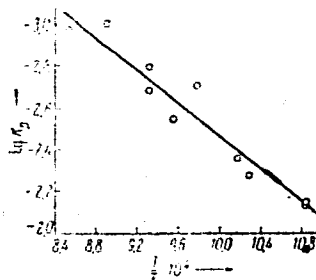
Ref. 2: K. Kuo, L. E. Persson, J. Iron and Steel Inst., part I, 78, 39 (1954); Ref. 5: C. McCabe, R. Hudson, J. Metals, No. 1<sup>a</sup> (1957); Ref. 8: F. D. Richardson, J. Iron and Steel Inst., 175 (1953).

ASSOCIATION: Tsentral'nyy nauchno-issledovatel'skiy institut chernoy metallurgii im. I. P. Bardina (Central Scientific Research Institute of Ferrous Metallurgy imeni I. P. Bardin)

PRESENTED: June 12, 1961, by G. V. Kurdymov, Academician

SUBMITTED: June 7, 1961

Fig. 2



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ACCESSION NR: AR4015650

S/0081/63/000/021/0030/0030

SOURCE: RZh. Khimiya, Abs. 218181

AUTHOR: Shvartsman, L. A.

TITLE: Some problems in the thermodynamics of iron-based alloys

CITED SOURCE: Sb. tr. In-t metallov. i iz. metallov. Tsentr. n.-i. in-ta chernoy metallurgii, v. 7, 1962, 345-362

TOPIC TAGS: ferro-alloy, ferro-alloy carbon activity, alloying element carbon affinity, carbon activity variation, iron based alloy

ABSTRACT: The author discusses problems relating to the behavior of low concentrations of carbon in ferro-alloys when alloying elements (AE) are introduced. Carbon activity at  $[C]$  = constant varies in the presence of AE. If the latter have a greater affinity for C than for Fe, then a carbide of the AE can precipitate when the solution is saturated. Carbon activity in the alloys was determined on a circulation unit used to study the equilibrium  $C + CO_2 = 2CO$ ,  $K = \frac{P_{CO}^2}{[C] P_{CO_2}} = r$ . The activity factor  $\gamma$  varies in the presence of AE and the equilibrium constant can be written as  $K = \frac{r_{AE}}{[C] \gamma_{AE}}$ . Metals to the left of Fe in the fourth row of the periodic system decrease the activity of C in fusion. Alloying  
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ACCESSION NR: AR4015650

with Co, which does not form a solid carbide, increases  $\gamma_C$  in the solution. Alloying with Ni also increases it. The less filled the d-phase, the greater the affinity for C and the greater the reduction of  $\gamma_C$  when AE (U, Mn, Cr) are introduced. The previously determined functions  $\Delta F_{V_2C} = -11,500 - 0.49 T \text{ cal}$  and  $\Delta F_{VC} = -10,300 - 1.37 T \text{ cal}$  are cited in the article. L. Reznitskiy

DATE ACQ: 09Dec63

SUB CODE: ML, PH

ENCL: 00

Card 2/2

OK  
1  
B

L1700

S/032/62/028/011/004/015  
B104/B102

AUTHORS: Petrova, Ye. F., and Shvartsman, L. A.

TITLE: Determination of carbon activity in solid iron

PERIODICAL: Zavodskaya laboratoriya, v. 28, no. 11, 1962, 1334 - 1337

TEXT: A method of determining the thermodynamic activity of carbon in iron by means of  $C^{14}$  in one experimental operation on several samples is described. The experimental arrangement consists of two parts: In one part of the apparatus an iron specimen containing a certain quantity of carbon tagged with  $C^{14}$  is placed in a transparent quartz tube to serve as a standard. In the other part, annular samples of pure iron free from carbon are placed in a quartz tube. The tube containing the samples is put in a furnace. Before the experiment, both tubes are evacuated in the cold state and are then annealed at  $\sim 10^{-5}$  mm Hg for about 24 hrs; after annealing, the experimental setup (Fig. 1) is filled with hydrogen (300 mm.Hg), and the furnace is kept at a certain temperature. The circulation of hydrogen produces methane, the composition of which, after reaching

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1

Determination of carbon activity...

S/032/62/028/011/004/015  
B104/B102

equilibrium, depends only on the temperature of the standard and on the concentration of the carbon contained in it. The composition is characterized by  $r = P_{CH_4} / P_{H_2}$ , where  $P_{CH_4}, P_{H_2}$  are the partial pressures.  $r$  can be

exactly determined by the method of R. P. Smith (J. Am. Chem. Soc., 68, 7, 1163 (1946)). The equilibrium gas mixture circulates over 10 - 12 iron samples free from carbon, so that carbon diffuses into the samples. After the experiment, the radioactivities of the standard and of the samples are compared whereby the carbon concentration in the samples is accurately determined. This supplies the data needed for finding the thermodynamic activity of carbon in the usual way, based on the reaction  $[C] + 2H_2(g)$

$= CH_4(g)$  with the aid of the law of mass action. There are 3 figures and 1 table.

ASSOCIATION: Tsentral'nyy nauchno-issledovatel'skiy institut chernoy metallurgii im. I. P. Bardina (Central Scientific Research Institute of Ferrous Metallurgy imeni I. P. Bardina)

Card 2/6 Z

S/O20/62/146/003/017/019  
B101/B144

AUTHORS: Petrova, Ye. F., Shvartsman, L. A.

TITLE: Thermodynamics of solid solutions in the system Fe - Ni - C

PERIODICAL: Akademiya nauk SSSR. Doklady, v. 146, no. 3, 1962, 646-648.

TEXT: The results obtained by R. P. Smith (Trans. Met. Soc. AIME, 218, 62 (1960)) stating that the carbon in solid solutions of the system Fe - Ni containing ~75 atom% Ni shows a minimum of solubility at 1000°C were checked. Experiments were performed on an iron-nickel alloy containing 73.5% Ni and on pure nickel, from which the constant  $K = P_{CO}^2 / P_{CO_2} [\%C] = r^0 [\%C]$  was calculated at 850, 900; 950, 1000, and

1050°C, where  $[\%C]$  is the carbon dissolved in the solid solution in % by weight. It was found for pure nickel:  $-RT \ln [\%C] = \Delta G^0 = 9700 - 4.95T$ , while the following holds for the Fe-Ni alloy:  $-RT \ln [\%C] = \Delta G^0 = 8370 - 3.60T$ . The heat of solution of carbon in the Fe-Ni alloy is lower than its heat of solution in pure nickel. The decrease in entropy of dissolution of C in the alloy accounts for the decrease in solubility

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Thermodynamics of solid solutions ...

S/020/62/146/003/017/019  
B101/B144

of C in the alloy. The cause of this decrease in entropy is an ordering of the alloy which renders incorporation of carbon in the lattice more difficult. There is 1 figure. The most important English-language references are: F. Richardson, J. Iron and Steel Inst., 175, 257 (1953); B. Fleischer, J. F. Elliott, The Physical Chem. of Metallic Solutions and Intermetallic Compounds, Nat. Phys. Lab. Symposium, no. 9, 1, paper 2F, London, 1959. ✓

ASSOCIATION: Tsentral'nyy nauchno-issledovatel'skiy institut chernoy metallurgii im. I. P. Bardina (Central Scientific Research Institute of Ferrous Metallurgy imeni I. P. Bardin)

PRESENTED: February 14, 1962, by G. V. Kurdymov, Academician

SUBMITTED: February 12, 1962

Card 2/2

ALEKSEYEV, V.I. (Moskva); SHVARTSMAN, L.A. (Moskva)

Thermodynamics of the reaction of formation of tungsten carbides.  
Izv. AN SSSR. Otd. tekhn. nauk. Met. i gor. delo no.1:91-96 Ja-F '63.  
(MIRA 16:3)

1. Institut metallovedeniya i fiziki metallov [Sentral'nogo nauchno-  
issledovatel'skogo institut chernoy metallurgii.  
(Tungsten carbide) (Thermodynamics)

ITKIN, V.F.; MOGUTNOV, B.M.; SHVARTSMAN, D.A.

Transformations due to heating of iron-nickel martensite.

Dokl. AN SSSR 161 no.5:1073-1076 Ap '65.

(MIRA 18:5)

1. Institut metallovedeniya i fiziki metallov Tsentral'nogo  
nauchno-issledovatel'skogo instituta chernoy metallurgii im.  
I.P.Bardina. Submitted November 5, 1964.

S/0279/64/000/002/0180/0185

ACCESSION NR: AP4029845

AUTHOR: Alekseyev, V. I. (Moscow); Shvartsman, L. A. (Moscow)

TITLE: Comments on the experimental data on the thermodynamics of  $\text{Mo}_2\text{C}$  and WC

SOURCE: AN SSSR. Izv. Metallurgiya i gornoye delo, no. 2, 1964, 180-185

TOPIC TAGS: molybdenum carbide, tungsten carbide, thermodynamics, transitional metal, metalloid, carbide

ABSTRACT: Recently, interest has grown in the study of thermodynamic properties of transitional metals, especially their compounds with metalloids and particularly carbides. The significance of the thermodynamic properties of molybdenum carbide and tungsten carbide is important for solving a number of technical problems. The authors attempt to explain the cause of the discrepancies among the data of recent research. Graphs of the temperature dependence are given as well as reaction formulas. It is shown that the direct experimental results of Gleiser's and Chipman's work on the thermodynamics of the formation reaction of  $\text{Mo}_2\text{C}$  (Gleiser, M., Chipman, I. Free Energy of Molybdenum Oxide and Carbide. J. Phys. Chem., 1962, vol. 66, p. 1539) confirmed the respective data presented in these authors' previous article (Alekseyev, V. I., Shvartsman, L. A. Svobodnaya energiya obrazovaniya

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ACCESSION NR: AP4029845

karbida molibdena  $\text{Mo}_2\text{C}$  (free energy of formation of molybdenum carbide  $\text{Mo}_2\text{C}$ ) Izv. AN SSSR OTN, Metallurgiya i toplivo, 1962, no. 6). The same agreement of results is found between the authors' other works (Alekseyev, V. I., Shvartsman, L. A. Termodinamika obrazovaniya karbidov vol'frama (thermodynamics of tungsten carbide formation) Izv. AN SSSR, OTN, Metallurgiya i gornoye delo, 1963, no. 1, p. 91 and Gleiser, M., Chipman, I. Free Energy of Formation of Tungsten Carbide, WC Trans. metallurgical Soc. AIME, 1962, vol. 224, p. 1278) dedicated to determining the thermodynamic characteristics of tungsten carbide formation. Orig. art. has: 19 formulas and 2 figures

ASSOCIATION: none

SUBMITTED: 10Jul63

DATE ACQ: 30Apr64

ENCL: 00

SUB CODE: ML

NO REF SOV: 002

OTHER: 007

Cord 2/2

ALEXSEYEV, V.I.; SHVARTSMAN, I.A.

Thermodynamics of certain plain and mixed transition metal carbides.  
Probl. metalloved. i fiz. met. no.8;281-304 '64. (MIRA 18:7)



PETROVA, E.F.; SHVARTSMAN, L.A.

Determination of the thermodynamic activity of carbon in  
chromium alloyed iron using radioactive  $C^{14}$ . Zhur. fiz. khim.  
38 no.3:765-766 Mr '64. (MIRA 17:7)

1. Institut metallovedeniya i fiziki metallov Tsentral'nogo  
nauchno-issledovatel'skogo instituta chernoy metallurgii  
imeni I.P. Bardina.

L 41515-65 EWG(j)/EWP(c)/EWT(m)/EPF(c)/EMP(i)/EPF(n)-2/EWG(n)/EPR/EMP(j)/T/  
EWP(t)/EWP(b) Pc-4/Pr-4/Ps-4/Pi-4/Pu-4 IJP(c)/RPL JD/WJ/JW/JG/AT/RM/TH 54  
ACCESSION NR: AP4043553 S/0020/64/157/004/0951/0953 5/  
B

AUTHORS: Surovoy, Yu.N.; Alekseyev, V.I.; Shvartsman, L.A.

TITLE: The thermodynamics of complexes  $(Fe_xMo_y)_2C$  carbides

SOURCE: AN SSSR. Doklady\*, v. 157, no. 4, 1964, 951-953

TOPIC TAGS: complex iron<sup>21</sup> molybdenum<sup>21</sup> carbide<sup>21</sup>,  $(Fe_xMo_y)_2C$ , thermody-  
namics, relative partial free energy, heat content, entropy,  $(Fe_{0.02}Mo_{0.98})_2C$ ,  $(Fe_{0.036}Mo_{0.964})_2C$ ,  $(Fe_{0.05}Mo_{0.95})_2C$ , carbon transi-  
tion

ABSTRACT: The thermodynamics of  $(Fe_xMo_y)_2C$  were investigated by determining the equilibrium between the carbides and gaseous mixtures of hydrogen and methane:  $C(\text{in carbide}) + 2H_2(g) \rightarrow CH_4(g)$ . The carbides were synthesized by heating pressed mixtures of the iron carbonyl, molybdenum and lamp black under vacuum at 1400C for 10 hours. Measurements were made by the circulation method described earlier by Alekseyev and Shvartsman (DAN, 133, No. 6, 1331 (1960)). X-ray analysis showed the 3 samples had an  $Mo_2C$  structure. Expressions were derived for the relative partial free energies of the carbon

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ACCESSION NR: AP4043553

2

in the carbides ( $\Delta G_C = \bar{G}_C - G_{\text{graphite}} = RT \ln a_C$ ), where  $a_C$  is the activity of the carbon in the carbides with reference to graphite,  $a_C = r/r^*$ ;  $r = P_{\text{CH}_4}/P_{\text{H}_2}^2$  was determined experimentally, and  $r^*$ , the equilibrium of  $\text{CH}_4 - \text{H}_2$  gas mixtures with pure graphite, was obtained from the literature. For  $(\text{Fe}_{0.02}\text{Mo}_{0.98})_2\text{C}$ ,  $\Delta G_C = -2360 - 9.66T(873-1123\text{K})$ ; for  $(\text{Fe}_{0.03}\text{Mo}_{0.96})_2\text{C}$ ,  $\Delta G_C = -2610 - 9.56T(873-1123\text{K})$  and for  $(\text{Fe}_{0.05}\text{Mo}_{0.95})_2\text{C}$ ,  $\Delta G_C = -9090 - 3.10T(873-1123\text{K})$ . The first term in these equations represents the relative partial heat content of carbon,  $\Delta H_C$ , and the coefficient of temperature represents the relative partial entropy  $\Delta S_C$  in the given temperature interval. Increasing the iron content in these complex iron-molybdenum carbides changed the thermodynamic characteristics of the carbon; increasing the iron increased the exothermic nature of the transition of the carbon from graphite to carbide; the entropy of the carbon in the carbide is reduced. Analogous effects of iron were observed in  $(\text{Fe}_x\text{Cr}_y)_2\text{C}_6$  type carbides. No explanation for these unexpected results is given.

Card 2/3

L 41515-65

ACCESSION NR: AP4043553

Orig. art. has: 2 tables and 9 equations.

ASSOCIATION: Institut metallovvedeniya i fiziki metallov Tsentral'-  
nogo nauchno-issledovatel'skogo instituta chernoy metallurgii im.  
I.P. Bardina (Institute of Physical Metallurgy and Physics of Metals,  
Central Scientific Research Institute of Ferrous Metallurgy)

ENCL: 00

SUBMITTED: 29Feb64

OTHER: 001

SUB CODE: TD, GC, IC

NR REF SOV: 001

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Card 3/3